THE FOUNDRY

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A Converter Steel Foundry for Diversified Work

Many Ingenious Devices Have Been Especially Designed for Use in This Plant Which Greatly Facilitate Operations

THE PAST few years have witnessed a tremendous growth in the number of converter steel foundries in the United States. This expansion has been due to a variety of causes among which the ability of converter operators to handle a constantly wider range of work, due to increased technical skill, has been prominent. Also, as technical problems have been mastered, the business opportunities in the field have grown larger, with the result that today there are several converter shops in the eastern section of the United States that rank with the foremost jobbing foundries of the country in point of output and variety of work handled.

Among the plants of that character is that of the Reading Steel Casting Co., Reading, Pa.; this corporation, which is the successor to the Brylgon Steel Casting Co., dates from 1906. The melting department of the Reading Steel Casting Co.'s plant comprises two cupolas and four converters of the company's own design, placed along one side of the main foundry bay. The larger cupola, in which the converter charges are melted, runs continuously and has a melting capacity of eight tons per hour. This is equivalent to four converter charges, since each converter has a capacity of two tons. The converters are tilted electrically and are controlled from a platform placed across the main bay in such a position that the operations may be readily observed. Oil burners are provided for baking the linings prior to a series of blows. It is customary to operate the converters in relays; according to this plan, two converters are used each day, turning

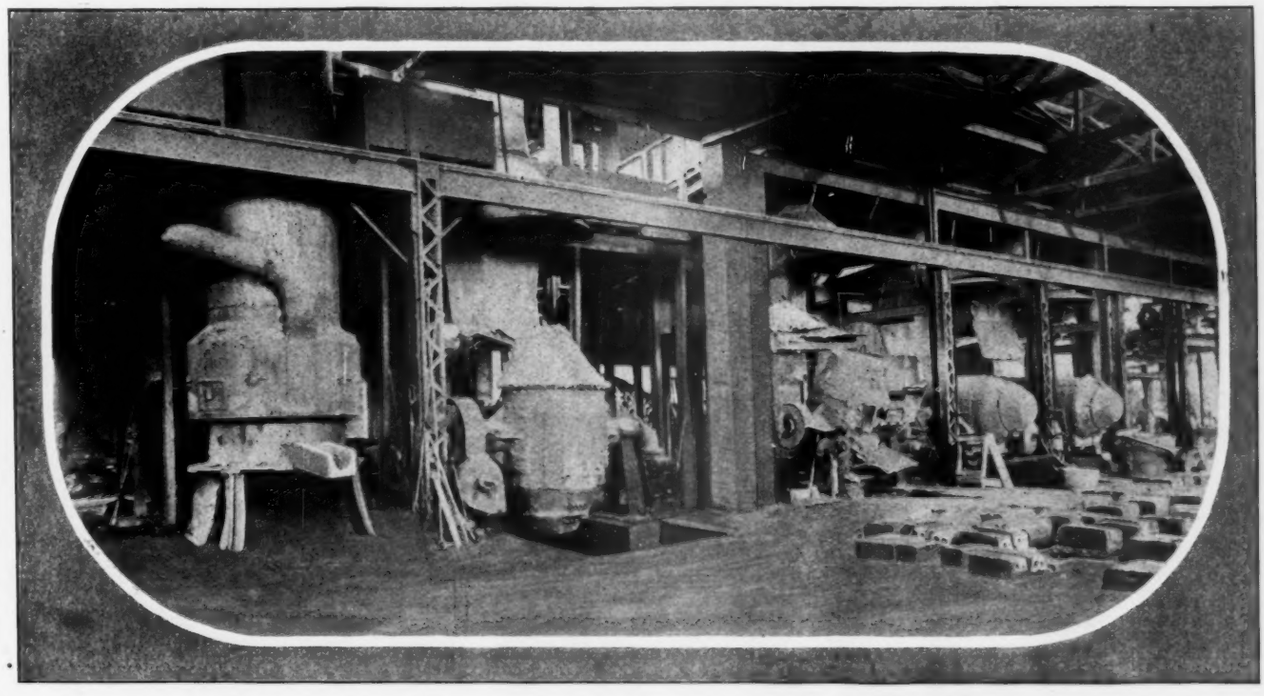


FIG. 1—MAIN BAY IN FOUNDRY SHOWING MELTING EQUIPMENT COMPRISING TWO CUPOLAS AND FOUR CONVERTERS

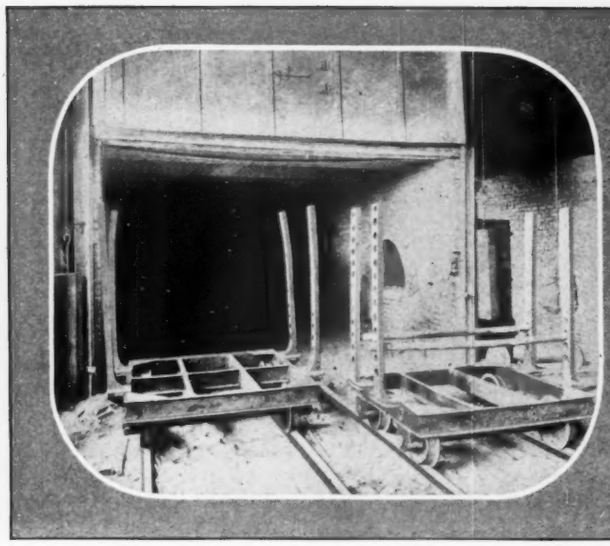


FIG. 2—DOUBLE TRACK MOLD DRYING OVEN SHOWING TYPE OF TRUCK WHICH MAY BE BUILT-UP TO SUIT THE LOAD

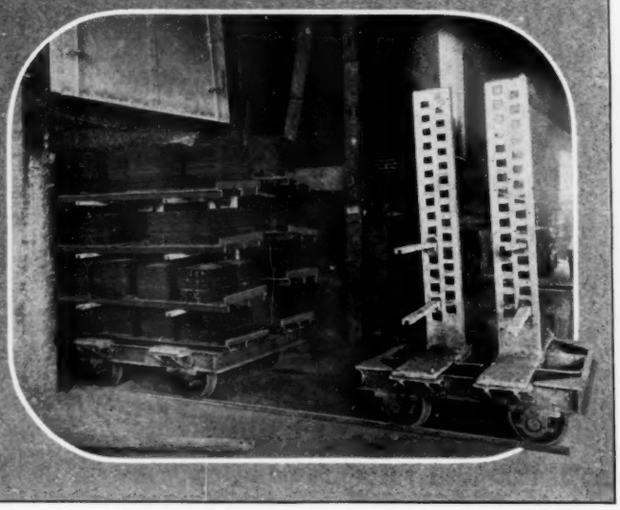


FIG. 3—IMPROVED TYPE OF TRUCK USED IN MOLD DRYING OVENS TO SAVE SPACE

out two heats, or four tons of steel, each, per hour. With this equipment, the company can pour 1,400 tons of steel a month and allowing 50 per cent for shrink heads, sprues, etc., the maximum output of finished castings is approximately 700 tons a month; this is nearly equal to the output of an open hearth foundry equipped with a 20-ton furnace.

The smaller cupola, which has an inside diameter of 36 inches, is employed for melting the mixtures of ferro-manganese and ferro-silicon used to recarburize the heats after blowing. Owing to the high prices now ruling on ferro-manganese, the company is making extensive use of spiegeleisen as a substitute. The only steels which are not recarburized by the addition of such a mixture are those which are specified under 0.10 per cent carbon and without manganese or silicon. To meet such special requirements, the steel is removed from the converters as blown, sufficient aluminum being added to remove the oxides. Low phosphorus pig iron containing approximately 1 per cent copper is used extensively. The metal mixtures contain from 40 to 50 per cent pig iron with 60 to 50 per cent steel scrap. It is stated that tests of the resulting steel, containing approximately 1 per cent copper have shown exceedingly satisfactory physical characteristics. This seems to controvert the contention that copper is a deleterious element when present in such large quantities.

Snap flask molding is employed very extensively, all but the very heaviest castings being produced by this method. The snap molds are made on the floor, on benches and on molding machines. The molding machine equipment in the snap flask department includes 16 power squeezers with cylinders ranging from 12 to 16 inches in diameter, and two jolters with 4-inch cylinders. The core shop is

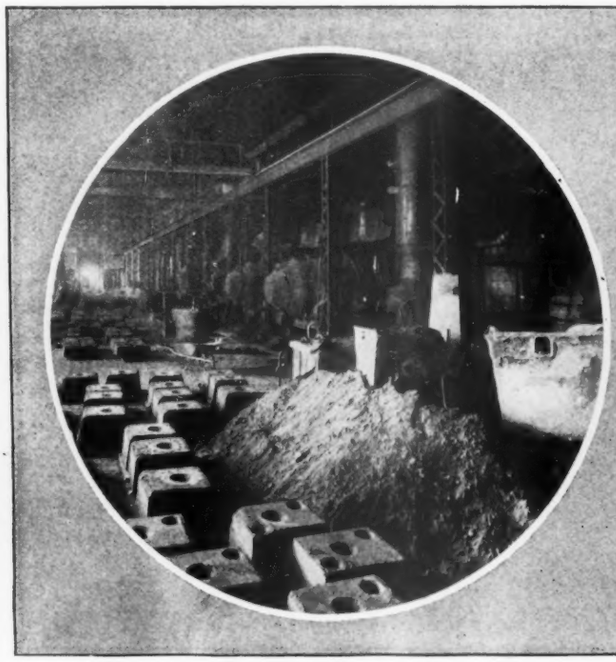


FIG. 4—STEEL BOXES LOADED WITH FRESHLY MIXED SAND. THESE BOXES ARE TRANSFERRED TO THE MOLDING FLOORS BY CRANES

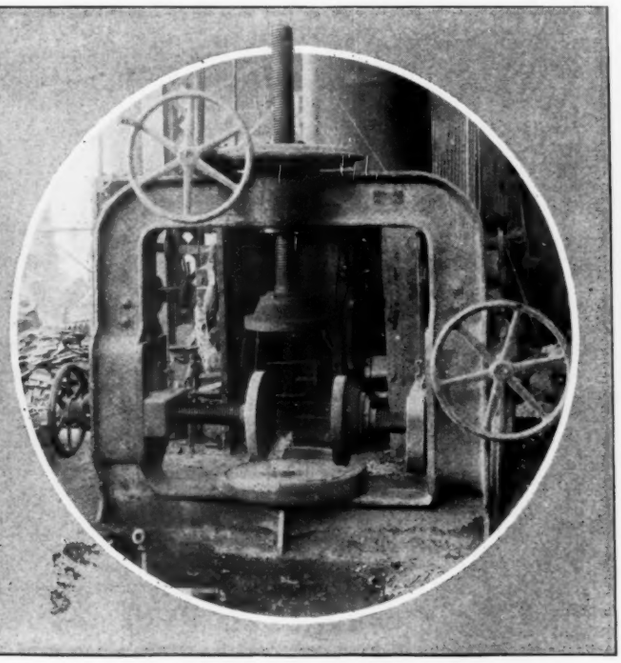


FIG. 5—SPECIAL MACHINE FOR HYDRAULICALLY TESTING VALVE AND FITTING CASTINGS

equipped with three 3½-inch jolt machines and an 8-inch jarring machine also has been provided for handling large work.

Practically all the molding is done on match-plates or with plain patterns. The snap flasks range from the usual small sizes up to 7 feet in length. When not in use, they are kept in a separate store room which is in charge of one man who keeps the flasks in repair. To get a flask, the molder must leave one in its place; thus all the flasks are continuously accounted for and none is left lying around the foundry where they take up valuable space.

The rigging which the company has devised for handling snap-flask molds is exceptionally interesting and permits of an extremely large output without congesting the molding floor. After being rammed, the snap molds are deposited on steel bottom boards, which are placed on specially constructed angle iron frames. These frames are 24 inches wide and 6½ feet long; each one will hold from one to five molds, depending on their size. As fast as the frames are covered with molds, they are loaded onto trucks and wheeled into the drying ovens. The frames, together with the type of rigging employed for handling them, are illustrated in Fig. 15. This rigging consists of hooks, supported on both ends of an equalizer beam which, in turn, is suspended from a hoist. The six hoists, which have a capacity of two tons each, are of the Shepard type, and are mounted on an overhead tramrail system which commands the entire floor space, 50 x 110 feet, in the snap molding department. The cranes may be transferred readily from one branch of the overhead system to another as required, thus affording great flexibility of service.

The snap molding department is provided with three coal-fired mold drying ovens. One, which is of the double-track type, accommodates eight trucks. The other two are provided with single tracks and have a capacity for four trucks each. Of particular interest are the two types of trucks employed. These are designed to take the maximum possible load, thus filling all the space in the ovens except such as must be left to permit the heat to circulate between the molds. The trucks, as shown in Figs. 2 and 3, are provided with low platforms, the molds being placed on racks which are inserted in the vertical columns. The upright members, in both types of trucks, are cast steel. In the truck shown in Fig. 2, the horizontal members of the rack consist of lengths of 3-inch wrought pipe. Due, however, to the constant warping of the pipe, the truck shown in Fig. 3 was designed and is said to have rendered exceedingly satisfactory service. This truck is provided with two vertical columns in each of which two parallel rows of slots are provided; the brackets are fitted into these slots as desired, and are held firmly in place by means of upper and lower flanges which securely grasp the tops and bottoms of the slots.

A separate portion of the foundry, 68 x 240 feet, is devoted to the production of large castings, such as motor truck and tractor parts, crank shafts, large valves and fittings for steam superheaters, and other pieces not suited to snap molding. A large proportion of this work is molded on a 3-ton jolt-ramming machine, which is served by a 1½-ton hoist suspended from a swinging boom. For the regular floor work, pneumatic rammers are used throughout. This department is provided with two large drying ovens and is commanded by two 10-ton electric traveling cranes and 2-ton Shepard traveling hoists. It has a concrete floor, as has also the snap-mold department.

Adjoining the floor-molding department is the core room, which is 50 x 62 feet in size. Practically all the cores are made on jolters, of which there are three in the core room, as mentioned previously. The core department, which is commanded by a 2-ton electric traveling crane, contains a machine for automatically mixing oil sand and also is provided with an oven of the drawer type. The oven is 36 x 8 x 8 feet; it contains 48 compartments, each of which may be opened and loaded without interfering with any of the others.

A 40 x 200-foot section of the main bay, in which the converters are located, is reserved for pouring the molds after they have come from the drying ovens. Practically all the work is poured with bottom-pour ladles, each of which will accommodate a full converter charge. This bay is commanded by three 10-ton electric traveling cranes, by which the ladles not only

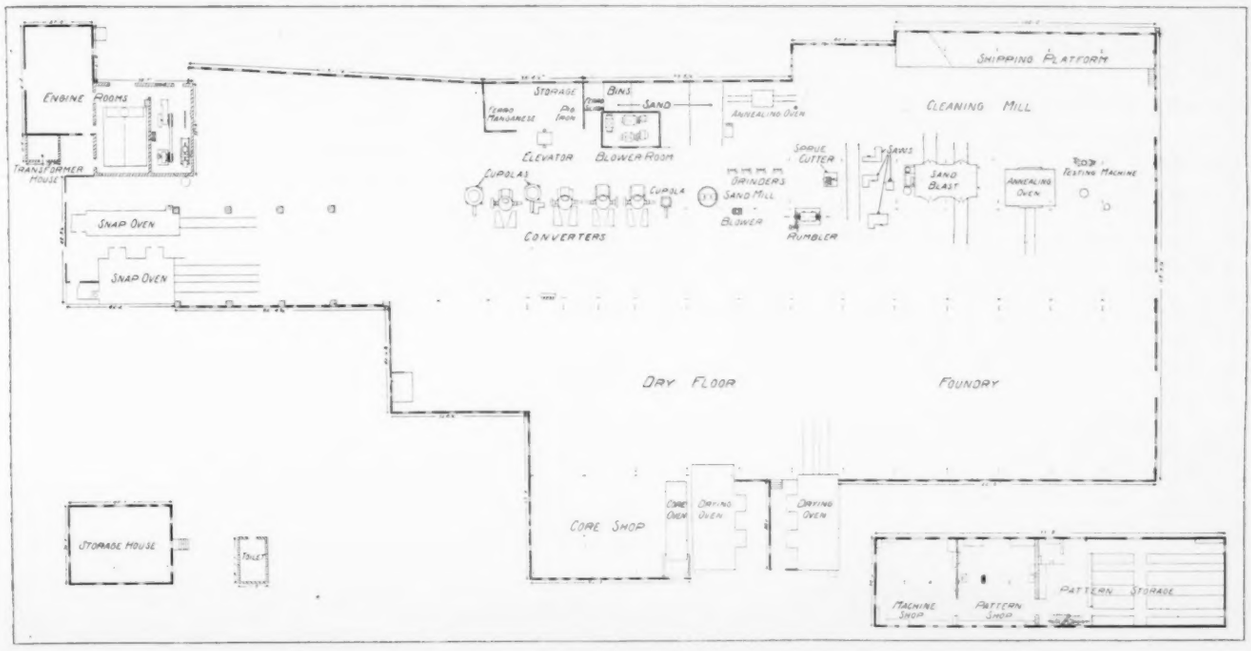


FIG. 6—GENERAL LAYOUT OF FOUNDRY OF READING STEEL CASTING CO., READING, PA.

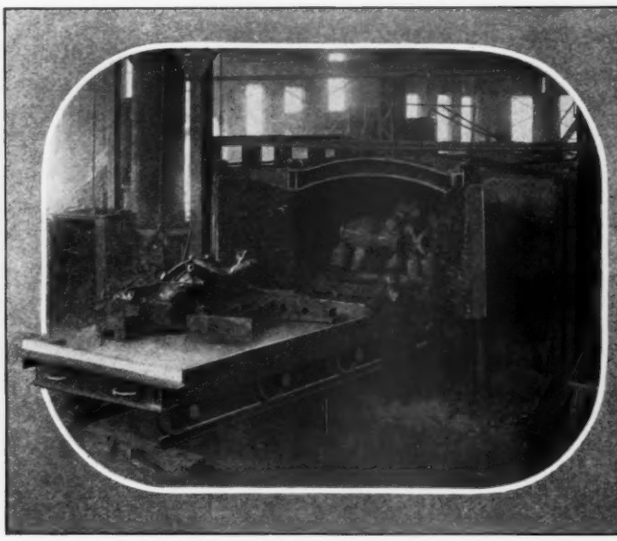


FIG. 7—EQUIPMENT FOR ANNEALING LARGE CASTINGS —WHILE CASTINGS ON ONE TRUCK ARE BEING TREATED THE OTHER TRUCK CAN BE LOADED

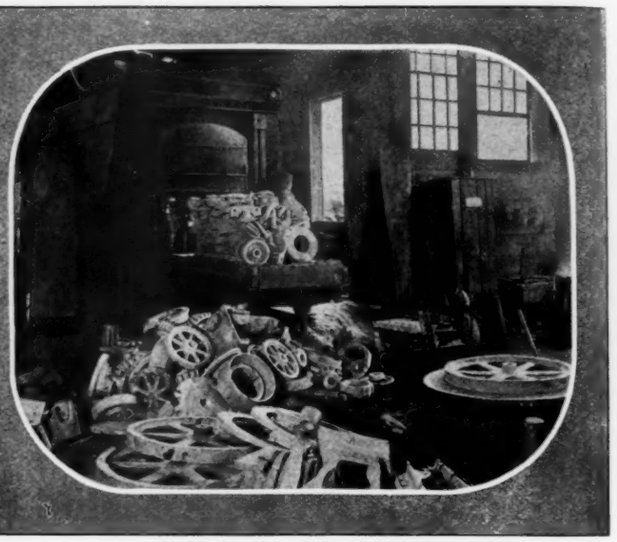


FIG. 8—ANNEALING OVEN FOR SMALL CASTINGS—THIS OVEN OPENS AT BOTH ENDS, PERMITTING THE LOADING OF ONE TRUCK WHILE THE OTHER IS IN THE FURNACE

are transported to all parts of the pouring bay, but may be transferred, if desired, to either of the two molding bays adjoining the pouring bay.

An unusual rig, designed for saving floor space, is that employed in relining and repairing the ladles. It consists essentially of a system of ball-bearing trucks on which the used ladles are deposited by the cranes and by means of which they are transferred from the main bay to a special compartment where they are put in shape for the next day's heat. These trucks are provided with circular steel platforms mounted on four wheels.

The cleaning department occupies a portion of the main foundry building. In addition to a 6 x 4-foot square tumbling barrel, two sand-blast chambers, several oxy-acetylene welding sets, sprue cutters, cold saws and a large number of stationary grinders and portable pneumatic chippers, the equipment includes four portable grinders of special design, which were developed by the company for its own use. As shown in Fig. 12, these machines are mounted on wheels, and are provided with a frame which supports a motor and grinding wheel in such a manner that they partly counterbalance each other. The motors, which are rated at 1½ horsepower each, are belt-connected to the wheels, and both the motor and the grinding wheel are provided with guards. Handles are provided at the grinding end so that the operator can apply the wheel to any part of the work. The cleaning department has a wood block floor which admirably resists the heavy wear to which it is subjected. This department is served by a 3½-ton electric traveling crane.

Prior to being shipped, every casting is subjected to an annealing process, in order that the metal may be as homogeneous and tough as possible. For this purpose two annealing ovens are provided, one for small and the other for large castings. These ovens are illustrated in Figs. 7 and 8.

FIG. 9—FRONT VIEW OF LARGE CORE OVEN OF THE DRAWER TYPE

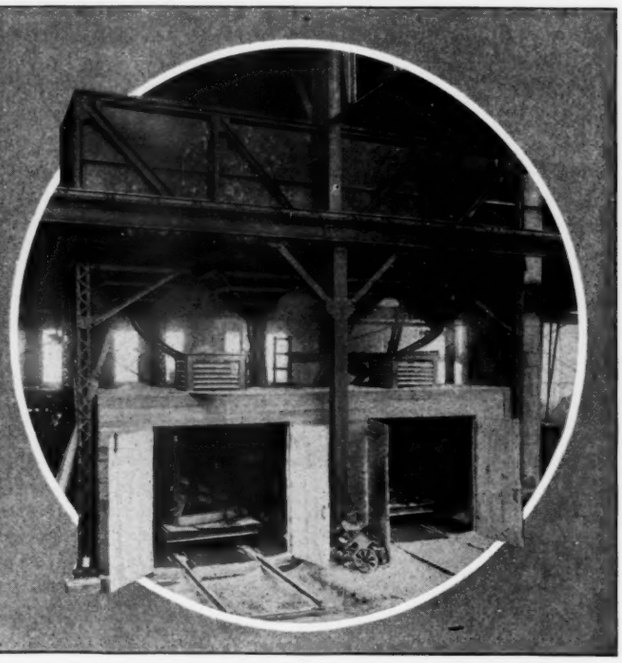


FIG. 10—SAND BLAST CHAMBERS SHOWING OVERHEAD SAND STORAGE BINS OF LARGE CAPACITY

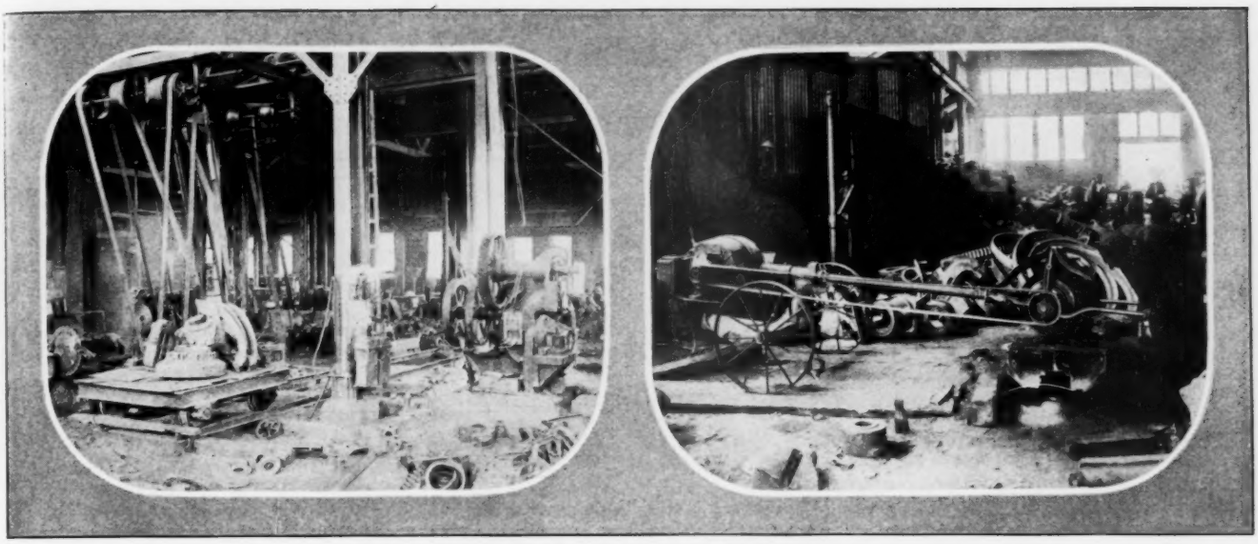


FIG. 11—PORTION OF CLEANING DEPARTMENT SHOWING MACHINES FOR REMOVING GATES AND SPRUES FROM CASTINGS

FIG. 12—PORTABLE, SWING FRAME GRINDER ESPECIALLY SUITABLE FOR FINISHING CASTINGS THAT HAVE BEEN WELDED BY THE OXY-ACETYLENE PROCESS

They are of the continuous type with doors at both ends and each one is operated with fuel oil and the larger one car may be loaded while the other is in the oven. The smaller oven is operated with fuel oil and the larger one with coal. Some of the castings are treated with an oil bath. Most of the output, however, is air chilled.

All manufacturing plants, unfortunately, are subjected to occasional losses of time due to unexpected and unpreventable break-downs in machinery or equipment. In periods of light demand such difficulties do not entail serious consequences. When business is brisk, however, and a plant is operating at capacity, nothing, unless it is a strike, creates as much dismay as a serious break-down. The Reading Steel Casting Co. has given this subject a great deal of consideration and in order that such delays shall not consume any more time than is absolutely unavoidable, it has laid in a full line of materials and spare parts for making repairs. These materials, together with the ordinary supplies, are kept in a two-story and basement storage building. The stores department is in charge of one man, who gives out the materials only on properly signed requisitions.

A portion of this building is occupied by the physical and chemical testing laboratories. The former contains a Riehle testing machine and a lathe for machining test parts. The chemical laboratory includes the usual apparatus required for iron and steel analysis.

The company originally encountered considerable difficulty in persuading its employes to make proper use of safety devices. For instance, the men at first were prone to wear goggles in their hip pockets, until one of them lost an eye which the goggles would have saved. This unfortunate accident had a salutary effect and since then goggles have been worn willingly by all workmen to whom their use is recommended. Weaning the molders away from the use of

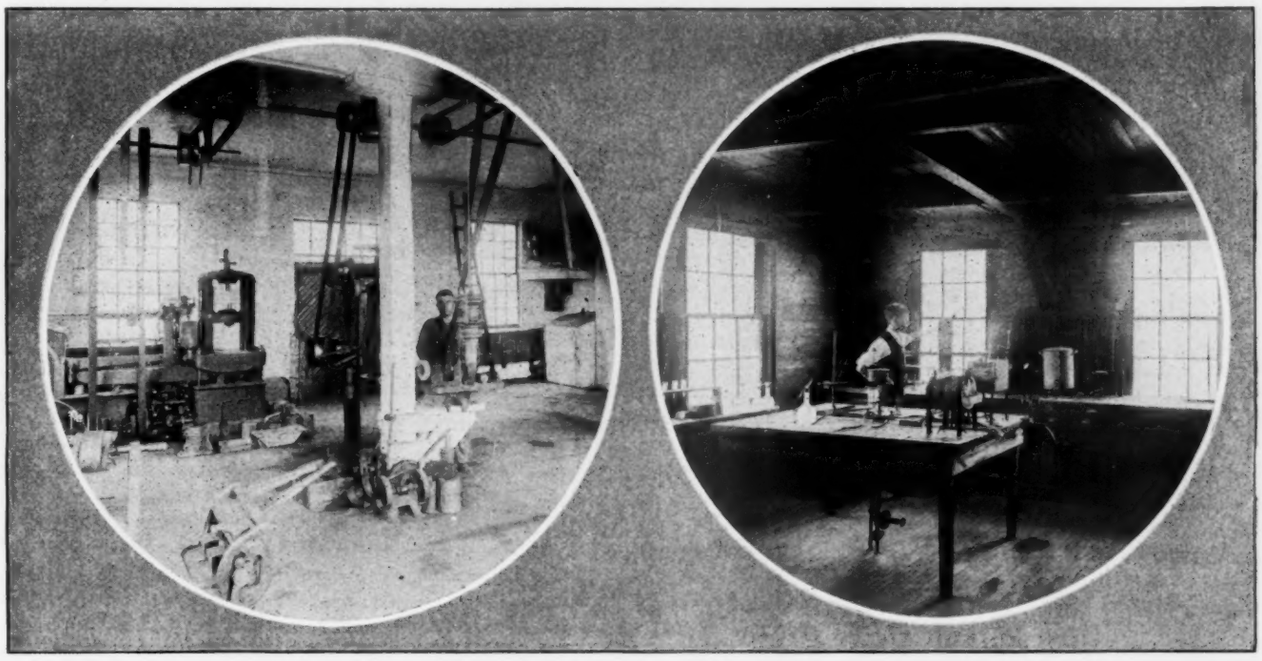


FIG. 13—PHYSICAL LABORATORY SHOWING RIEHLE TESTING MACHINE

FIG. 14—CHEMICAL LABORATORY EQUIPPED FOR IRON AND STEEL ANALYSIS

shoes which are unfit for foundry work also proved rather difficult. When the company originally laid in a stock of shoes of the type developed by the National Affiliated Safety Organizations, the men showed small interest in the improved footwear. It finally was decided to distribute a few pairs free of charge, thus paving the way to an appreciation of the shoe. So popular has this shoe since become that the company now sells to its employes from 30 to 40 pairs a week, at cost prices.

Welfare and Relief Association

In addition to the encouragement of the use of safety devices in the shops, the company looks after the welfare of the employes in a general way. Fig. 16 shows a large new building recently erected at a cost of $12,000 to take care of the work of the Reading Steel Casting Relief Association. This is an organization of employes that provides sick benefits, etc., for its members. This building is believed to be one of the finest of its kind in the country. The basement contains hot and cold shower baths, wash basins, lockers, etc., enabling every workman at the plant to remove all signs of labor at the close of the day, and to change his clothing and go home refreshed and rehabilitated. The first floor contains a billiard and pool room, a co-operative store, a reading room supplied with current issues of a number of trade papers and most of the popular magazines, a completely equipped kitchen and a hospital. The assembly hall occupies the entire second floor. This is provided with a platform at one end and is suitable for a great variety of purposes. The appreciation of the employes is measured by the extent to which they use the building during most of their hours of recreation. In addition, their wives use it freely during the day. In this way the building serves a dual purpose, making it possible for every member of the family to participate in and enjoy this novel feature of welfare work, to the fullest extent.

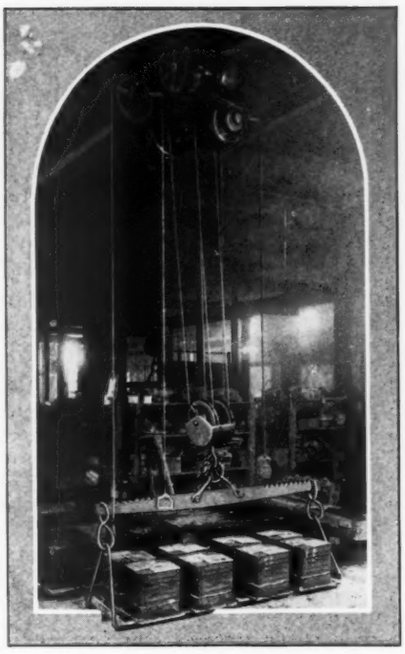


FIG. 15—CARRIER FOR TRANSFERRING MOLDS TO DRYING OVENS

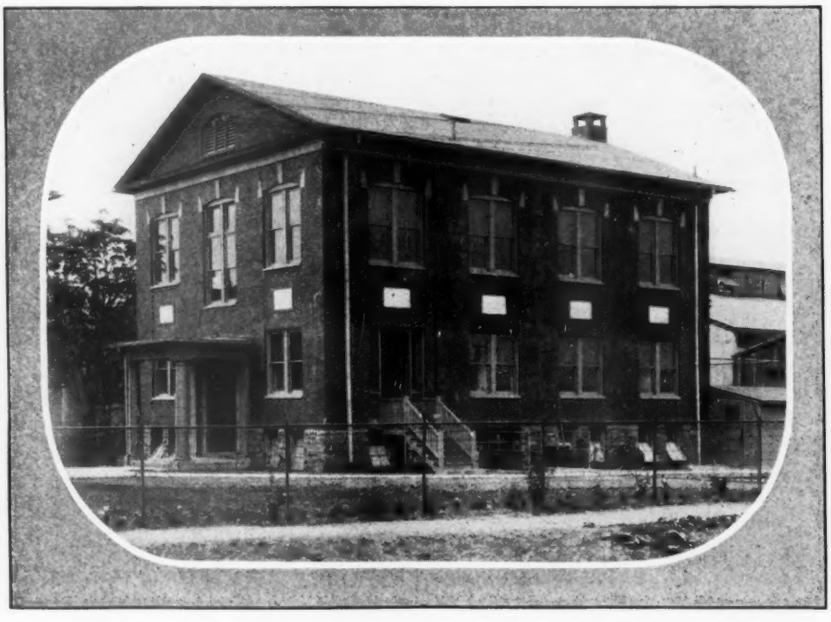


FIG. 16—HOME OF READING STEEL CASTING RELIEF ASSOCIATION

Variations in Malleable Shrinkage

Question:—What is the cause of the wide variation in the shrinkage of malleable castings poured from the same heat? We have taken test bars, ½ x 1-inch cross section and 12 inches long, poured from the same heat, from various parts of an annealing oven, and when annealed they varied in size considerably. As a rule, we have found that the greatest variation, either long or short, is in castings in the lower part or the upper part of the annealing pot stack. Unfortunately, our results are not sufficiently reliable to enable us to prevent short castings occasionally. We have tried putting the short castings back and reannealing them, but this does not correct the trouble.

Answer: — The question submitted is difficult to answer. Every malleable iron manufacturer has the same experience and to effect a solution of the difficulty he can proceed only along two lines. First, to melt the metal quickly and to tap and pour in the shortest time possible. Second, to fire the annealing ovens so steadily that the differences in temperature at top and bottom of the pots are at a minimum. So far as the melting process in the air furnace is concerned, the metal at the moment of tapping, in the case of long heats particularly, is quite different from that of the last iron drained out. Even the silicon changes rapidly. Also, the temperature is much higher at the end of the heat and the chances of obtaining oxidized metal in dangerous quantity are at the maximum. The result must be a different contraction in the first casting as compared with the last. This is observed regularly in malleable shops and particularly when the heats begin to run off, this situation will become distressing. At the time when the railroad coupler was made of malleable iron, a period of foundry difficulties always was accompanied with short castings and many were consigned to the scrap heap for that reason. Add to the above, variation in the expansion of a casting brought about in the anneal through variation in the temperatures to which the castings have been exposed, and it readily can be seen that the contraction difficulties are accentuated. Thus long and short hard castings may get much or little annealing expansion. These things may balance each other, but they also may aggravate each other. An extra short, hard casting may not expand sufficiently in the anneal, thus giving double trouble. Therefore, the necessity for uniformity in practice is apparent and short heats, quick pours and uniform temperature anneals are essential to the manufacture of good malleable iron.

How Castings for Automobiles Are Inspected

What One Foundry Has Done to Maintain a Uniform Product and the Results Obtained in the Improvement of Quality by Proper Inspection

THE relation between inspection and the final cost of castings is a subject which can be discussed at great length, since a properly organized and efficient inspection department is a more potent factor in reducing the scrap loss in a foundry than any other single unit of the foundry organization.

With the exception of the foundry, the trend, for the past ten years in manufacturing industries, has been toward the most complete development of their inspection departments. I assume that foundrymen have looked upon this department as an unnecessary expense rather than as an aid in operating their plants more efficiently and successfully. Without a knowledge of what is demanded of the machine shop product, the foundry heads have always maintained that their output was not being treated fairly by the machinists. Because the foundry, for so long a period, has been making castings without a standard of quality, the machine shop, whose product depends mainly upon the foundry, has been compelled to establish its own standard for accepting or rejecting castings, and with regard only for its own protection it has placed such rigid specifications on castings that it has entailed a great hardship on the foundry.

Inspection in Automobile Industry

This has been true of the automobile industry to a greater extent probably than any other line of work with which the foundry has ever been connected. The development of this industry has been so rapid and on so broad a scale that it has been difficult for the foundry to meet the constantly changing demands of the automobile engineers. Consequently, foundries have been compelled to sustain many losses unjustly; and being without the protection of competent inspection departments, there has been no redress, since the technical requirements of the engineers were beyond their comprehension and understanding. Many of these losses, however, could have been placed where they rightfully belonged, provided the foundry had had a corps of properly trained inspectors.

When the writer first began to manufacture automobile castings, he found it an extremely difficult problem to know when castings were right or wrong; but in an honest endeavor to establish a standard of quality and to develop an inspection department that would maintain this standard in his own factory, he first employed an expert foundryman. This experiment, however, soon proved a failure, since the inspector was partial to the foundry in all his reports and by nature antagonistic to the machine shop. The foundryman was replaced by a patternmaker, in the belief that his knowledge of patternmaking, his ability to read blue prints and his knowledge of foundry methods would eminently fit him for the position which the writer was endeavoring to establish. The patternmaker also proved a failure, since, in addition to having the same faults as the expert molder, he constantly tried to protect the pattern department's product in use in the foundry.

Before making the third attempt, the inspection department was removed from the direct supervision of the foundry and a thoroughly practical machinist was placed in charge. In filling the position, an effort was made to get a man who was broad enough to fully protect the machine shop and, at the same time, make due allowances for the slight variations which occur in foundry practice. His progress at first was slow, as he was greatly handicapped by the antagonistic attitude of the foundry organization, since 'the molders objected strenuously to accepting the views of a machinist. It was doubly difficult for him when it became necessary to make corrections in the methods of molding. However, with the knowledge he had of the manner in which the castings were to be machined and of the parts that had to be absolutely accurate, his suggestions regarding changed and improved foundry methods soon became invaluable to the molder in reducing his scrap. The machinist, having had a more thorough training in gas engine practice than the foundryman, could prevent the molders from making changes in either gas or water passages, altering port cores, or, in fact, in making changes in any part of the casting which would be contrary to good engine practice. Also, having had experience in the use of jigs and tools in the machine shop, it was simple for him to apply this knowledge to coremaking and molding and to insure uniform castings, wooden gages were soon replaced with steel and iron fixtures.

The non-interchangeability of cores and core assemblies was a source of perplexity to the man trained in machine shop practice, and in endeavoring to locate the cause of this lack of uniformity so as to eliminate fitting and filing in the foundry, it was soon determined that patterns and core boxes would have to be repaired to insure the perfect fitting of loose pieces and removable parts. Even after the equipment was put in proper condition, it was almost impossible to convince the molder that it was unnecessary to file cores as formerly, since the force of habit and past practice governs the molding industry to such an extent that it is often difficult to introduce new ideas.

Inspection Should be Positive and Accurate

The means of inspection employed should be positive and accurate. If the casting is intricate or complicated, or has a number of machined surfaces, standard gages can readily be made and the casting placed in the same relative position in which it is to be held while being machined, and the finished surfaces and cored openings can be checked quickly and accurately. Some time ago I was making a four-barrel, *en-bloc* cylinder casting, with the crank case integral, on which it was necessary to check 20 or 25 points before it was shipped. A fixture was designed in which the casting was placed and every point to be checked was inspected at one handling. A duplicate fixture was later made by the customer and his inspection department used exactly the same method as I did when pasisng on the castings. In a great many cases a check of this kind may show an error in the casting which could be laid out and favored slightly without additional expense in the machining operation, whereas, if this is not taken care of in the foundry, the machine shop will handle the casting in the regular way and reject it as an imperfect casting.

Automobile cylinder castings must be tested hydraulically before shipment from the foundry to determine

Presented at the Atlantic City meeting of the American Foundrymen's Association.

porosity which may exist in the water jackets. This is done most economically and successfully where a constant pressure is maintained on the casting for a time long enough to give the water an opportunity to sweat through any pores which may exist in the casting. However, this cannot be detected as positively by the use of a hand pump, where the pressure is raised gradually and maintained for a short interval. It also is a decided advantage to the foundry to maintain a high pressure on the water jackets, thus forcing the water into the pores of the casting, which will rust any porosity which may exist. A great many times castings are returned to the foundry because the jackets leak. However, when again tested at the foundry the trouble is not apparent as the leak had been closed by rusting, and this results in an argument which, in a majority of cases, could have been avoided if the casting had been properly tested before shipment.

To maintain a uniform foundry product is difficult, owing to the fact that the human element enters into the production of the casting to such a large extent. I have had jobs that have not given any trouble for months, when suddenly a greatly increased scrap loss would occur without apparent reason. Without an inspection department this trouble would probably not be discovered until the customer began to machine the castings, and probably by that time many thousands of imperfect castings would have been made, shipped, or in process of manufacture. A coremaker may have omitted a core wire, or a loose piece may have been lost from a corebox or pattern. A small core may have been omitted by the molder, or a thousand and one other things may have gone wrong without having made any apparent change in the appearance of the casting; unless a thorough inspection is made of every piece before it is shipped from the foundry, serious losses are bound to result.

Large Stocks of Rough Castings

Today, when single automobile companies are producing from 100 to 1,000 automobiles per day, it is absolutely necessary for them to carry a large supply of rough castings in stock. This becomes an extreme hazard to the foundry unless every casting has passed through a competent inspection department. In fact, I know of automobile manufacturers who keep two and three sets of cylinder patterns in stock to guard against any emergency which may arise. This is necessary unless a foundry has an inspection department to locate these troubles before castings are shipped and is able to remedy them before serious loss is incurred as a result of the customer carrying a stock of several thousand defective castings.

Only too frequently the machine shop returns castings to the foundry which have been spoiled through its own neglect, and unless protected with a competent inspection department, the foundry eventually absorbs nearly all the machine shop loss. But when such rejected castings are again inspected by the foundry and the machine shop is compelled to tag each casting with the reason for its return, rejected castings are reduced 75 per cent. There also follows an increased measure of respect between the machine shop and the foundry and business relations are decidedly more satisfactory.

Machinability of the Iron

The work of the inspection department does not end with checking the mechanical troubles of the foundry and core room, but it is necessary that its reports cover the machinability of the iron. The inspection department should be provided with a lathe and drill press to turn and drill castings to determine whether the iron is satisfactory. It is true, that the chemist has his analysis and test bars, but he must be checked in this as a great many things can happen between the charging door and the shipping room which will upset all his calculations. Then, too, it is always a good plan for the inspection department to take a cut off certain castings to determine whether there are any draws, shrinks or porosity which should have the attention of the metallurgist or the foundry organization.

Foremen and superintendents, in their executive capacity, can recommend methods for reducing scrap when such losses are directed to their attention, but without an inspection department these losses may occur for a considerable time before they become cognizant of them; and even then, if the loss is not stopped at once, another period of loss is experienced until it again has the executive's attention. An inspection department detects loss, and after a careful analysis, determines the cause and sees to it that the loss is stopped at once or that some good reason is given.

Most foundries maintain a salvage department which should be under the supervision of the inspection department. Any castings sent to the salvage department should be reported as scrap to the foundry. If this is not done, no effort may be made to eliminate the troubles.

The rapidity with which the inspection department is able to make reports of defects, with their causes, to the foundry organization, is a factor of the utmost importance. I have found it good practice to run the cleaning room during the night and have the first rough inspection report ready by 8 or 9 a. m. the next morning to enable the foundry to check errors in core setting and bad molding which had caused defective castings on the previous day. A report of only the number of castings lost or scrapped is not sufficient, but a reason should be given for the loss of each casting. Many times it is hard to determine the reasons for a defect, but by a careful inquiry and analysis it is always possible. Many times the superintendent and foreman are unable to give a reason, but when the inspector goes to the workman he finds that he has been ordered to do the work in a certain way and the molder will not criticize the judgment of his superiors unless shown that his individual record is being damaged by an excessive scrap loss. When this personal interest is instilled in the molder and coremaker it is comparatively easy to get them to co-operate in reporting when cores are wrong, or core boxes and patterns are out of shape; in this way they really inspect their own equipment and work and thereby contribute to the reduction of scrap. It is this latter objective towards which the inspection department should constantly work, not alone to increase its own efficiency and skill in checking and inspecting castings, but to instill in the molder and coremaker the necessity for accurate and careful workmanship and the spirit of co-operation and willingness to receive instruction relative to ways and means of reducing their scrap. With this spirit instilled in the workman, half the battle for the reduction of scrap is won.

Reports Form a Permanent Record

I have always found it good practice to make a permanent record of all the reports from the inspection department, compelling it to record the reason for scrapping each casting, sending one copy daily, or as early as possible, to the foundry and filing one copy for future reference. A recapitulation and an analysis of these reports every week or 10 days, giving the average loss during that period, gives a more comprehensive knowledge of the operation of the foundry than that gained from the analysis of

a single day's report. Unfortunately, I have found that it is always the tendency of the foundry organization to say :"Yesterday's troubles will be cured today." However, today's troubles are something else, but with a complete story of the past week's scrap one has an excellent argument demanding a more determined effort from the foundry organization to overcome these same losses in the future. Also, a record of this kind is helpful in starting new orders for work which previously has been made in the foundry, since the elimination of the liability of repeating bad practices will insure a decreased scrap loss.

The cost of maintaining an inspection department is quite an item unless results accruing from its operation reduce costs, either in manufacturing or in the reduction of the number of castings returned.

The success or failure of a foundry is found in its scrap pile and if the inspection department is a factor in reducing the scrap of a plant, it has paid its own cost many times. For example, if the direct and indirect costs of a foundry are $400 per day and the average scrap loss is 20 per cent, the cost of good castings is increased $100. An inspection department of five men would easily take care of a foundry of this size at a cost of about $15 per day. If by this means the scrap loss is cut to 10 per cent, there is at once a saving of $55 less $15, the cost of inspection, which would net $40. Not only is the cost of good castings reduced in the ratio of reduced scrap, but all indirect costs are at the same time cut to a minimum, as laborers throughout the whole plant are handling material which pass out of the shipping room door and are returning a revenue; while with a high scrap loss, fully 15 per cent of the labor in the foundry is consumed in handling scrap castings from the molding room to the cleaning room and to the charging floor. At the same time, the foundry is able to increase its production without the addition of equipment such as molding machines, flasks, etc., and is then working on an efficient basis, reducing costs, cutting out superfluous indirect expenses and increasing the output.

Competition Eliminated

The foundry that endeavors to inspect its own castings and prevent its organization from trying to impose defective material upon its customers, with the hope that they may overlook it or in some way be forced to use it, will eliminate nearly all competition. When a machine shop forms a connection with a foundry which gives service and quality, keeping all casting troubles in the foundry, it is a difficult problem for a competing foundry to get an opportunity to quote prices. Also, the shop with a reputation for quality will get from 10 to 15 per cent more for its product than the foundry not so protected. It also instills in the customer a feeling that he is being treated fairly and makes him less critical, while the rejections are less subject to the erratic temper of his machine shop foreman. Also, the machine shop organization will be more inclined to work with the foundry management when castings show some slight defects, especially when they are notified in advance that certain castings are not up to standard, but that corrections have been made and that with a slight adjustment in their fixtures, they will be able to use them. With this feeling of fair play and co-operation between machine shop and foundry, rejections can be reduced to the minimum.

It always has been my contention, that the inspection department, once properly organized in a foundry, is of the utmost importance and will determine, to a large extent, the failure or success of the entire business. The proper use of reports and information gleaned from the inspection department will reduce the scrap in the foundry, which in turn reduces overhead expense, increases output, standardizes quality, makes satisfied customers, eliminates competition and insures the success of the business.

Machine-Molding a Grinding Mill Frame

By George Buchanan

IN FIG. 1 is illustrated a grinding mill frame, the pattern of which, for many years, was mounted on a follow-board. For coring-out the interior of the casting a dry sand core was employed which, of course, was made in a separate core box. These castings usually are made in lots of 100. As previously molded, a dry sand core was necessary, as the use of a green core added materially to the molding cost. The difficulty encountered with the green sand core was mainly in handling as the core had to be lifted out of its box and subsequently had to be accurately set in the mold. As several flanges were concealed when the core was being set in the mold, it was found exceedingly difficult to locate the core without breaking or crushing some part of the edges of these flanges, and as they were practically concealed, they could not be patched. As a result, many castings were lost. Previous difficulties, however, were eliminated entirely when this pattern was mounted on a stripping plate molding machine and the cost of molding and coremaking was reduced practically 75 per cent. In Fig. 2 the cope pattern is shown on a stripping plate machine in position for ramming. The two pedestals are stooled and the flask, when rammed, is lifted from the machine by a crane. Fig. 3 is a view of the core box and the core plate, the latter being provided with pins which match corresponding openings in the core box. In Fig. 4 the core has been rammed and the core box has been lifted off. The finished core is shown on the plate in its proper position for locating in the cope, while above the core the cope is shown elevated ready to be lowered into position. When the cope has been lowered over the core, the plate and flask are clamped together, rolled over, the clamps are removed and after rapping, the plate is lifted off. By the use of this core plate the green sand core is accurately located in the cope, as shown in Fig. 5. No grid is employed to strengthen the core and only a few

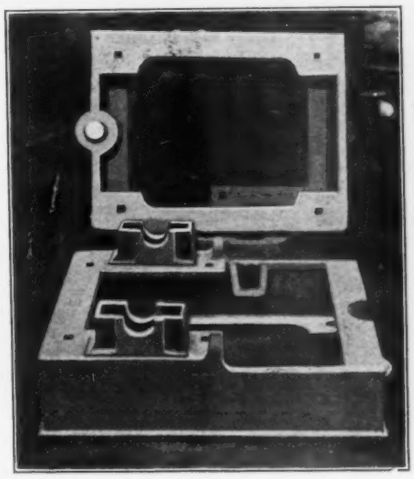


FIG. 1—INSIDE AND TOP VIEWS OF A GRINDING MILL FRAME

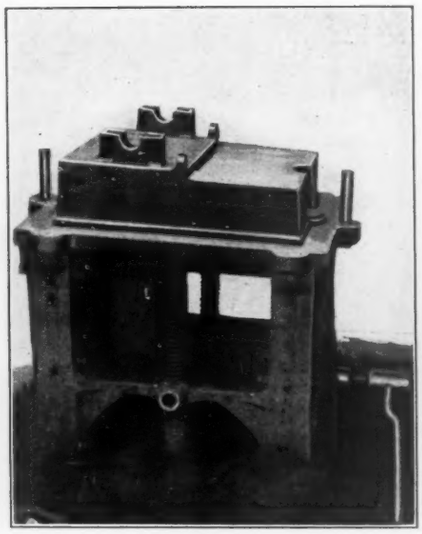


FIG. 2—THE COPE PATTERN MOUNTED ON A STRIPPING PLATE MACHINE

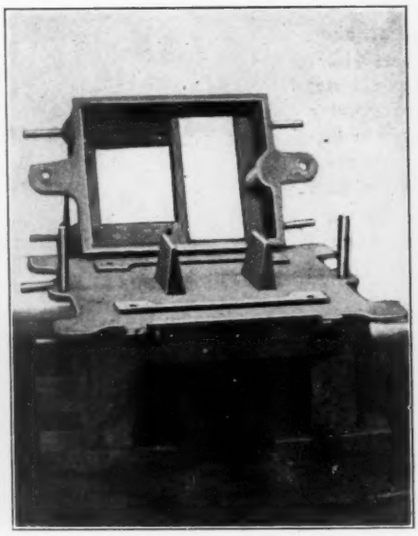


FIG. 3—CORE PLATE AND CORE BOX FOR MAKING THE GREEN SAND CORE

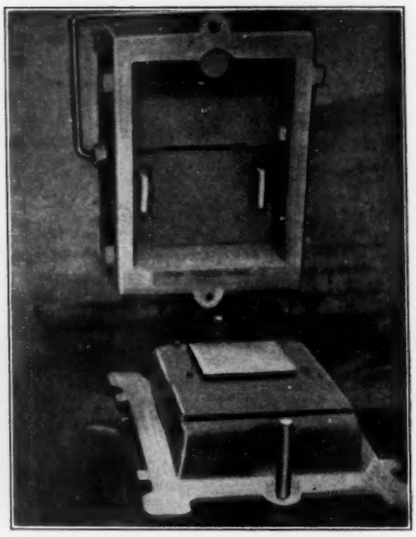


FIG. 4 — LOWERING THE COPE OVER THE GREEN SAND CORE ON THE CORE PLATE

5-inch iron rods are used underneath the flanges. The two upright, pyramidal sections on the core plate, Fig. 3, serve to vent the core and also to hold the core in position on the plate while it is being rolled over. These uprights prevent the core from shifting when the mold is inverted and serve their purpose exceedingly well. The drag is rammed on the back of the core plate. The use of the green sand core insures clean castings with practically no fins.

Foundrymen Elect Officers

The twentieth anniversary of the New England Foundrymen's Association was celebrated with a dinner at the Exchange Club, Boston, on Wednesday, Jan. 12. Officers for the ensuing year were elected as follows: President, W. B. Leach, Hunt-Spiller Mfg. Corp., Boston; vice president, Stephen E. French, Athol Machine Co., Athol, Mass.; treasurer, George H. Gibby, Gibby Foundry Co., East Boston; and secretary, Fred F. Stockwell, Barbour - Stockwell Co., Cambridge. The following were elected members of the executive committee: Charles A. Reed, Reed, Fears & Miller, Boston; T. R. Scott, Browne & Sharpe Mfg. Co., Providence, R. I.; H. Paul Buckingham, Arcade Malleable Iron Co., Worcester, Mass.; L. J. Harley Jr., Harley Co., Springfield, Mass.; and Charles L. Taylor, Taylor & Fenn Co., Hartford, Conn.

Smelting Company Organized

The United Smelting & Aluminum Co., New Haven, Conn., which recently completed a plant for the manufacture of aluminum ingots, alloys, etc., has been incorporated with $175,000 capital, fully paid in. The new plant already has proved inadequate to meet the heavy demand for its product and a tract of land, 80 x 114 feet, has been purchased adjoining the present property upon which a new building will be erected immediately. It will contain four or five reverberatory furnaces of a special type designed for melting aluminum, thereby practically doubling the company's present output. In addition to producing aluminum ingots, alloys and granulated aluminum, babbitt metal alloys and spelter will be made. The officers of the company follow: Harris Lapides, president; Michael Lapides, vice president; Louis Lapides, secretary, and Abe Lapides, treasurer. Louis Lapides is general manager of the company, L. M. Birle, for a number of years affiliated with the United States Reduction Co., Chicago, is manager of sales and Michael Lapides, a graduate of Gallavdet college, Washington, D. C., and Carnegie Institute of Technology, will have charge of the laboratories and the technical department of the company. The firm of Abe Lapides, former owners of the United Smelting & Aluminum Co., has passed out of existence, having been absorbed by the new corporation.

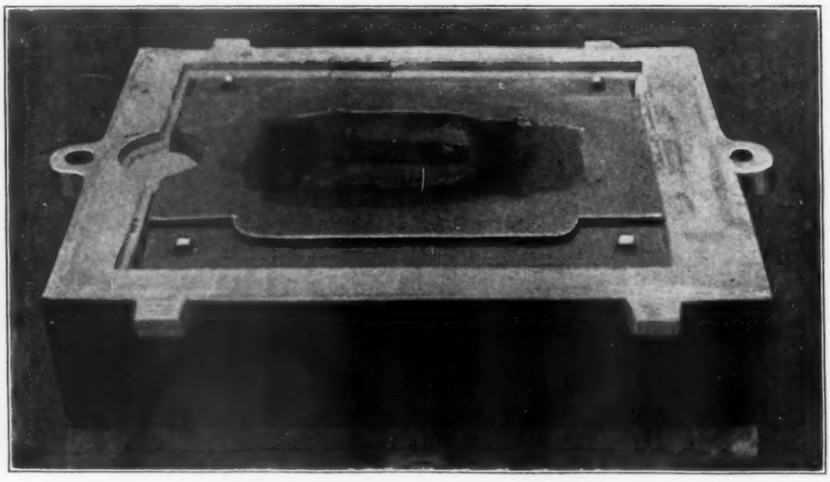


FIG. 5—THE COPE SHOWING THE GREEN SAND CORE IN POSITION

At the annual meeting of the stockholders of the American Metal Products Co., Milwaukee, officers were re-elected as follows: Peter J. Weber, president; Henry C. Brelie, vice president; William J. Eberle, secretary and treasurer, and Richard Gaertner, general manager. The foregoing officers, with Charles E. Helm and August Littmann, constitute the board of directors. The recent purchase of a larger plant and additional equipment was ratified.

Problems in Pipe Foundry Practice Discussed

The Use of Interchangeable Patterns is Considered and the Economies They Effect in Soil Pipe Manufacture are Pointed Out

By R Robertson

THE progress with which the science of domestic sanitary engineering has advanced within comparatively recent years, has affected the pipe founding industry in no small degree, and the trade which has developed through this channel has become an important adjunct to that already embraced by the iron founder. This is a class of work which involves a certain amount of special knowledge from those whose duty it is to handle it, and in order to secure trade, founders must be prepared to design and work out in detail, complete schemes of drainage from rough sketches, and to do this successfully they must be conversant with the laws governing sanitary engineering. The subject of sanitary engineering is without our province and, therefore, we intend to confine ourselves in the present article to the consideration of some of the problems confronting foundrymen dealing with this class of trade.

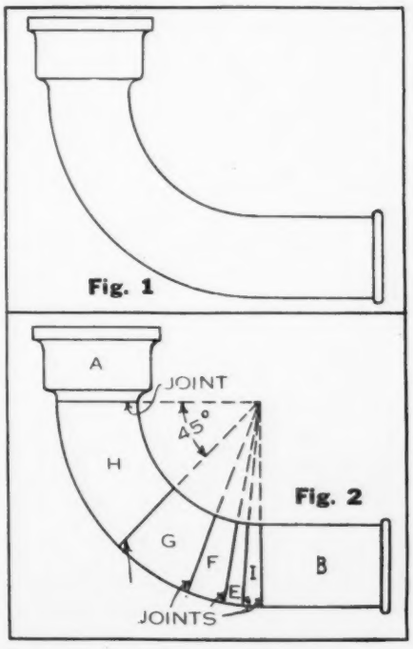
The introduction of cast iron pipes dates back to a very early period in the history of iron founding. The free use of cast iron pipes has solved many of the difficulties which had to be faced by our municipal authorities in the development of our large cities. We have only to mention water, gas and sanitation and the use for these pipes becomes apparent.

Advantages of Cast Iron Pipe

Cast iron possesses many of the qualities which go to form a perfect material for pipes to be used either above or below the ground level. The advantages possessed by pipe made in cast iron are being recognized more every day; in fact some of our municipal authorities have already framed by-laws relating to underground pipes for sanitary purposes, prohibiting the use of any material other than cast iron.

Cast iron is probably more extensively used for the manufacture of pipes than for anything else. In many foundries the making of pipes is a specialty and there are few foundries which are not called upon from time to time to make a pipe in some form or other. In order to carry on a successful trade in pipe founding it is necessary to have in stock a large number of patterns for the various connections, from which bends, branches, etc., to different angles and shapes may be made as required. Unless some well defined system be adopted when preparing these, the founder will find his stock of patterns multiplying in no small degree, involving a large amount of capital from which there may be little return.

In a great many cases, the number of these patterns can be reduced to a minimum by making them in such a way that their parts are interchangeable. A simple example will suffice to illustrate the point to which we wish to direct attention. Let us take the case of a



FIGS. 1 AND 2—BEND AND PATTERN FOR THE SAME MADE IN SEVEN PIECES

pipe bend, Fig. 1. If the pattern for this bend be made in seven pieces as shown in Fig. 2, no less than 16 patterns of pipe bends to different angles may be obtained. The piece, *H*, is cut to form an angle of 45 degrees at the center of its curve; *G* to form an angle of 22½ degrees; *F* to form an angle of 11¼ degrees; *E* to form an angle of 5⅝ degrees and *I* to form an angle of 5⅝ degrees.

Figs. 3 to 18, are the various combinations with the angle of the bends formed therewith. The following shows the pieces used in Figs. 3 to 18 to obtain bends at various degrees of curvature:

Pieces	Degrees
A, H, G, F, E, I, B	90
A, H, G, F, E, B	95⅝
A, H, G, F, B	101¼
A, H, G, E, B	106⅞
A, H, G, B	112½
A, H, F, E, B	118⅛
A, H, F, B	123¾
A, H, E, B	129⅜
A, H, B	135
A, G, F, E, B	140⅝
A, G, F, B	146¼
A, G, E, B	151⅞
A, G, B	157½
A, F, E, B	163⅛
A, F, B	168¾
A, E, B	174⅜

From the foregoing example, which is only one of many which might be given, it will be noted that by adopting this system of interchanging, with a few pieces of patterns and their joints judiciously arranged, the possibilities of changes are unlimited. It is admitted of course, when a large number of castings are required from a particuluar pattern it is more economical to make a complete pattern.

Before passing from the particular part of our subject we might note that pipe bends are not always ordered in the form of the angle they contain; they are often ordered as ¼ bend, ⅛ bend, $\frac{3}{16}$ bend, and, so on. To determine the actual angle of the bend which these fractions denote, adopt the following rule: Multiply the number of degrees in a circle (360) by the numerator of the fraction and divide by the denominator, then subtract the result from 180 and the answer will give the number of degrees in the bend, or

$$180 - \frac{360 \times \text{numerator}}{\text{denominator}} = \text{angle of bend}$$

Example: Find the angle of a $\frac{3}{16}$ bend—

By formula

$$180 - \frac{360 \times 3}{16} = \text{angle of bend}$$

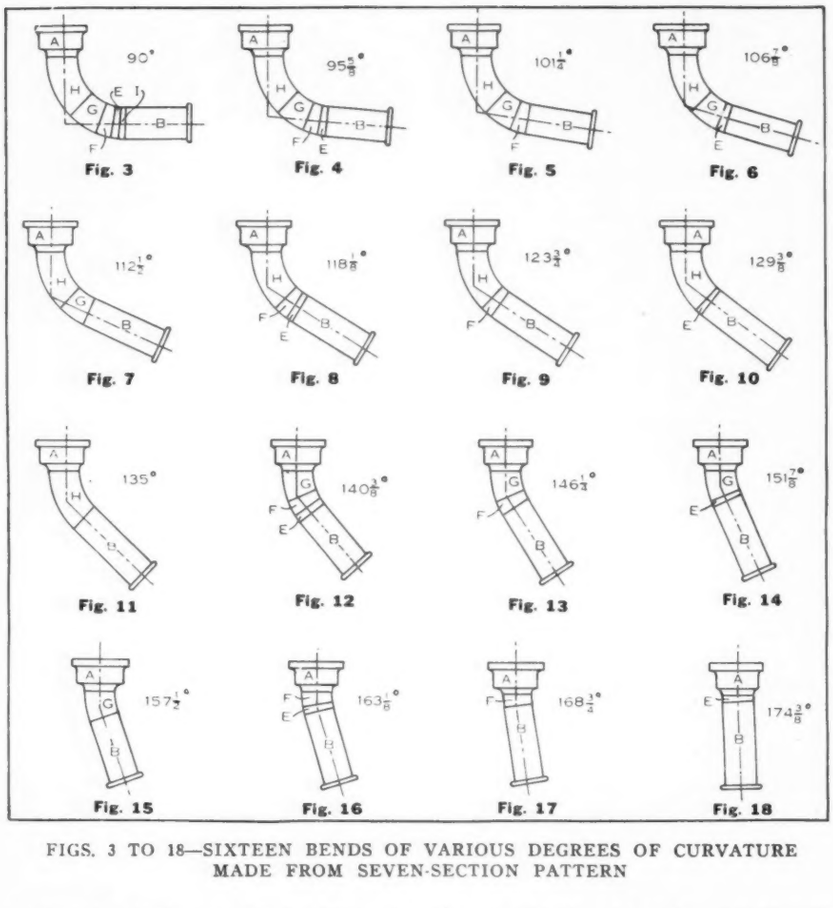
$$180 - 67\frac{1}{2} = 112\frac{1}{2}$$

Therefore the angle of a $\frac{3}{16}$ bend is 112½ degrees.

We give in tabular form the value and angle of the common bends for handy reference:

Bend		Degrees
¼	(Fig. 3)	90
$\frac{5}{32}$	(Fig. 5)	101¼
$\frac{3}{16}$	(Fig. 7)	112½
$\frac{7}{32}$	(Fig. 9)	123¾
⅛	(Fig. 11)	135
$\frac{5}{32}$	(Fig. 13)	146¼
$\frac{1}{16}$	(Fig. 15)	157½
$\frac{3}{32}$	(Fig. 17)	168¾
1/64	(Fig. 18)	174⅜

As this article has special reference



FIGS. 3 TO 18—SIXTEEN BENDS OF VARIOUS DEGREES OF CURVATURE MADE FROM SEVEN-SECTION PATTERN

to the pipe trade associated with sanitary work, it might be in order at this stage to give a list of the definitions and symbols used by sanitary engineers on their plans, from which the iron founder has to take his particulars. These are as follows:

Symbol	Definition
S. P.	Soil pipe
D. P.	Down or drain pipe
R. W. P.	Rain water pipe
V. P.	Ventilation pipe
W. P.	Waste pipe
I. P.	Inspection pipe
C. A.	Clearing or cleaning arm
C. A. B.	Clearing arm bend
I. C.	Inspection chamber
G. I.	Gulley inlet
S. T.	Syphon trap
A. E.	Access eye
V. A.	Ventilation arm
L.	Lavatory
F. A. I.	Fresh air inlet
D. T.	Disconnecting trap
I. T.	Intercepting trap
I. B.	Inspection branch

Fall—The gradient to which a pipe is laid.

Datum—The base line from which all levels are taken.

Seal—The amount which the tongue of the trap dips from the surface of the water which lies in the trap.

Cascade—The water fall between the invert of the inlet and the invert of the outgo of a trap.

Invert—The channel or bed on which the sewage runs.

Velocity—The rate of motion of the sewage.

The following rule should be adopted to determine the amount of fall in a drain:

Multiply the diameter of the pipe by 10 and give a fall of 1 in the result.

For example, the fall for a 6-inch pipe would be, by rule, $6 \times 10 = 60$. Therefore 1 in $60 =$ fall of a 6-inch pipe.

The following table calculated from the foregoing rule is given for general reference:

Diameter of pipe, inches	Fall
2	1 in 20
2½	1 in 25
3	1 in 30
3½	1 in 35
4	1 in 40
4½	1 in 45
5	1 in 50
6	1 in 60
7	1 in 70
8	1 in 80
9	1 in 90
12	1 in 120

A consideration of the following points is essential in the designing of schemes of drainage in cast iron:

Water closets should be most carefully trapped at the W. C. pan, as the pipes from these communicates directly with the drain.

All wastes, sinks, baths, lavatories and rain-water pipes should never join directly to the pipe leading from the W. C., but should discharge into the open, over trapped gullies. Should there be more than one waste, sink, bath, lavatory or rain-water pipe in the same line, there is no need for trapping each independently. These may be joined and led to a trapped gulley near the drain, this is just as effective as if each were trapped separately and as a much more economical arrangement. Every facility should be given for inspecting the drains. Inspecting chambers should be placed at every change in the gradient and change of direction in the main drain.

Pipes which are to be imbedded in the ground should not be less than ⅜ inch thick.

Soil and water pipes above the ground level are sometimes made $\frac{3}{16}$ inch, but ¼ inch is recommended.

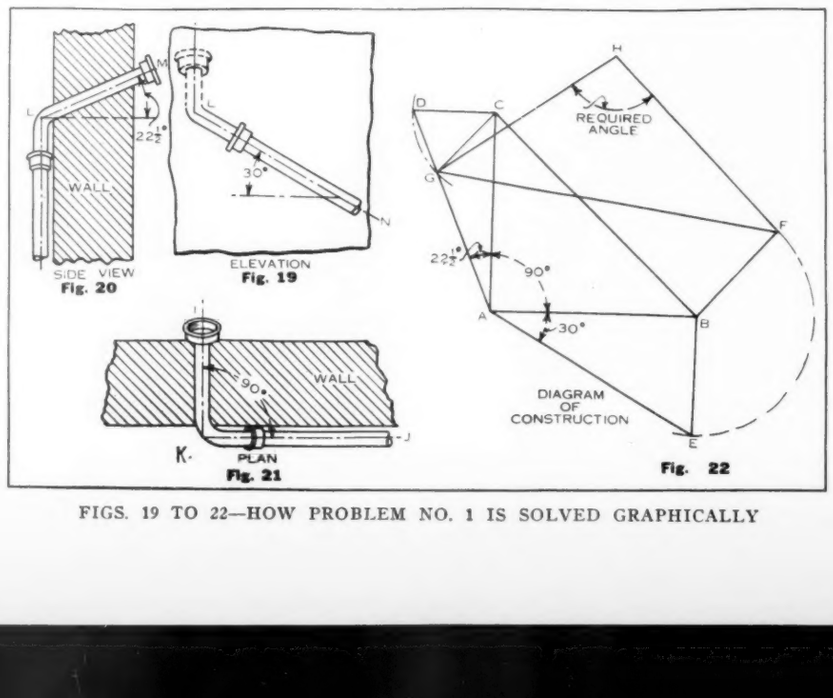
Rain water and ventilation pipes are made from ⅛ to ¼ inch thick.

In working out the details connected with cast iron pipes for sanitary purposes, much difficulty is often experienced in arriving at the various levels, true length of the branch drains and other information which is necessary to ascertain before the work can be put in the shop.

In the following we give several examples of these pipe problems, with their solutions, a study of which will assist the founder in overcoming many of the difficulties to be met with in this particular branch of foundry work.

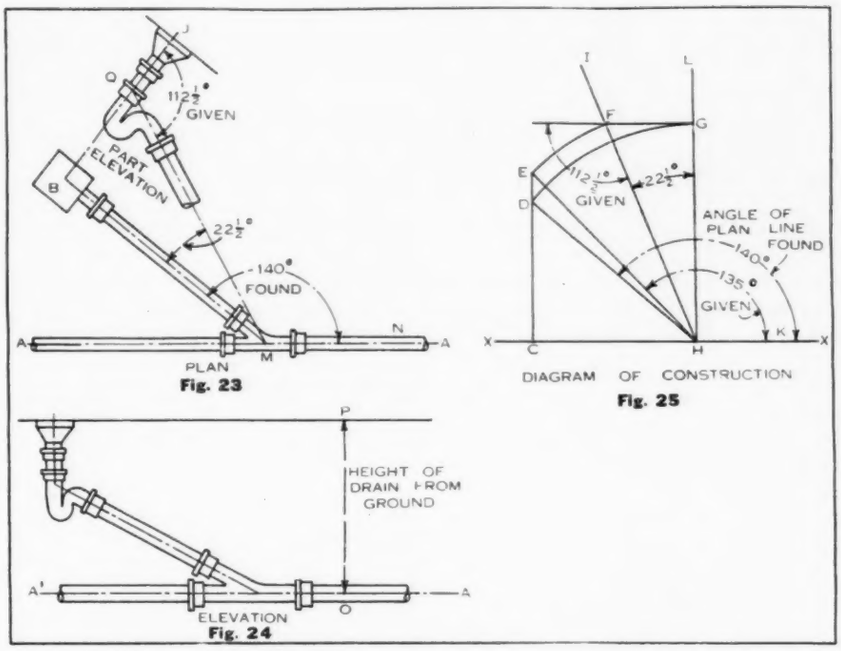
Problem No. 1

Find the *true* angle of a cast iron bend when the hub and spigot tails are on the rake.



FIGS. 19 TO 22—HOW PROBLEM NO. 1 IS SOLVED GRAPHICALLY

Figs. 19, 20 and 21 show the elevation, side view, and plan of a cast iron pipe bend going through a wall. The tail *L M* rises at an angle of 22½ degrees and *L N* falls at an angle of 30 degrees. It is required to find the true angle of the bend. Draw *C A* and *A B*, Fig. 22, any length, but the angle *C A B* must be the same as the angle *I K J*, Fig. 21. In the present case the angle is shown at 90 degrees, but this may be any angle. Join *C B*, draw *A E* at 30 degrees to *A B* and from *B* draw *B E* at right angles to *A B*. Now draw *A D* at 22½ degrees to *A C*, and from *C* draw *C D* at right angles to *C A*. Now draw *C G* at right angles to *C B* making *C G* = *C D*, and draw *B F* at right angles to *C B*, making *B F* = *B E*; join *G F*.



FIGS. 23 TO 25—HOW PROBLEM NO. 2 IS SOLVED GRAPHICALLY

Draw *F H* equal to *A E* and *G H* equal to *A D*, and the angle *G H F* now found is the correct angle of the cast iron bend going through a wall at 22½ degrees and falling at 30 degrees.

Problem No. 2

To find the true length of the branch drain, the point of intersection of the branch with the main drain, using a stock or standard branch and trap, the main drain being level or nearly so. The solution of this problem is shown graphically in Figs. 23, 24 and 25.

The line *A A*, Fig. 23, represents the main drain (level or nearly so) and *B* a point where a syphon trap with a tail at 112½ degrees has to be arranged to meet the main drain, the junction being formed by a stock branch pipe of 135 degrees.

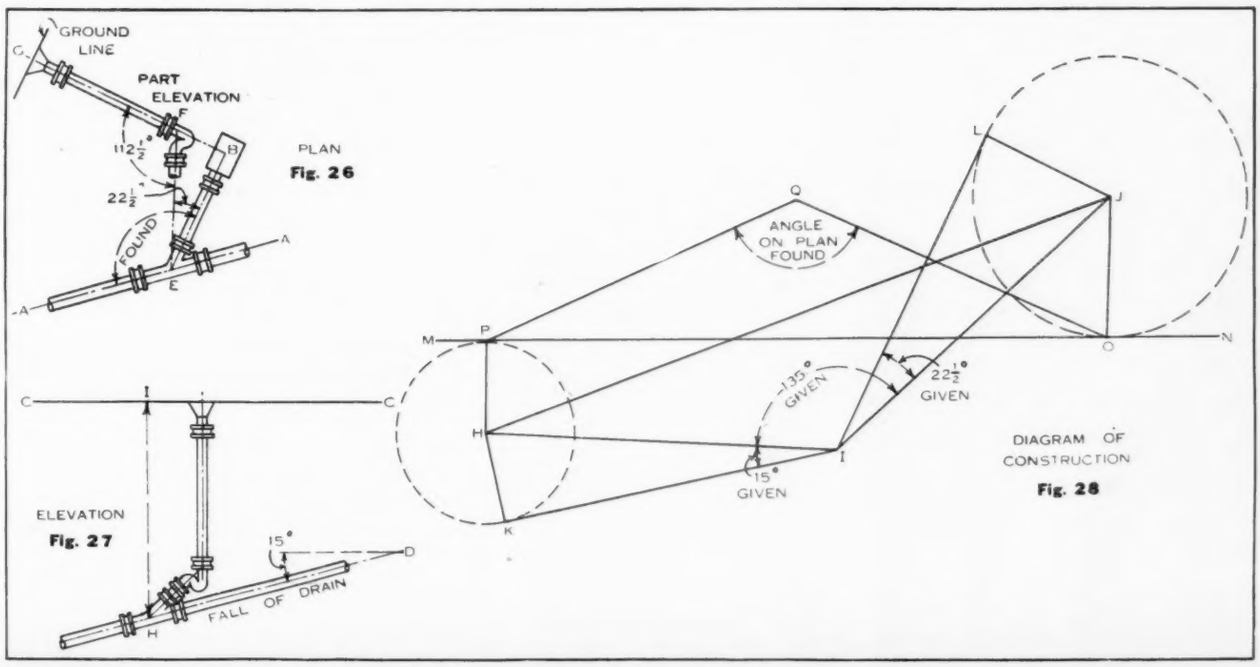
It is required to find the true length of the branch and the point at which the branch meets the main drain.

On the line *X X*, Fig. 25, take a point *C* and draw *C E* at right angles to *X X*; from *E* draw *E H*, making the angle *E H K* = 135 degrees, being the angle of the stock branch to be used. From *H* draw *H L* at right angles to *X X* and draw *H I*, making the angle *I H L* equal to 22½ degrees, being the fall of the syphon trap from the horizontal. With center *H*, and radius *H E* draw a curve cutting *C E* in *D*; join *D H* and the angle *D H K* is the correct angle on the plan of the branch revolved round to give a rise of 22½ degrees. Now draw *B M*, Fig. 23, making the angle *B M N* = angle *D H K* and draw *B J* = *O P*, Fig. 24; from *M* draw *M Q*, making the angle *M Q J* = 112½ degrees.

Now *M Q J* is the true length of the branch taking a stock syphon trap with a tail at 112½ degrees, and joining the main drain with a stock branch at 135 degrees, and *M* is the point where the branch meets the main drain.

Problem No. 3

To find the true length of the branch drain, the point of intersection of the branch with the main drain, using a stock branch and a stock syphon trap,



FIGS. 26 TO 28—THE GRAPHIC SOLUTION OF PROBLEM NO. 3

the main drain having a fall. This problem is solved graphically in Figs. 26, 27 and 28.

The line *A A*, Fig. 26, is the plan of the main drain which has a fall of 15 degrees and *B* a point where a trap with a tail at 112½ degrees has to be arranged to meet the main drain, the junction being formed by a stock branch at 135 degrees.

It is required to find the true length of the branch and the point at which the branch meets the main drain.

Draw *H I J*, Fig. 28, to 135 degrees, the angle of the stock branch, and join *H J;* draw *I K* with a fall of 15 degrees to *H I;* join *H K* making *H K I* a right angle; draw *I L* at 22½ degrees to the line *I J;* join *L J* making *I L J* a right angle. With center *J* and *J L* as a radius, draw a circle, and with *H* as center and *H K* as radius, draw a circle.

Draw a line *M N* tangent to these two circles and from *J* draw *J O* at right angles to *M N* and from *H* draw *H P* at right angles to *M N*.

Now make *O Q* = *I L* and *P Q* = *I K*, and the angle *P Q O* is the angle on the plan formed by the stock branch at 135 degrees rising at 22½ degrees and the main drain falling at 15 degrees.

From *B*, Fig. 26, draw *B E* making the angle *B E A* = angle *P Q O;* draw *B G* at right angles to *E B* making *B G* = *I H*, Fig. 27, and from *E* draw *E F* at 22½ degrees to *E B*. Now *E F G* is *the true length* of the branch and *E* the point where the branch meets the main drain.

Problem No. 4

To find the true length of the branch, the point of intersection of the branch with the main drain, and the level of the trap, the trap being at the ground level, using a stock branch and the main drain being level or nearly so. This problem is solved graphically in Figs. 29 and 30.

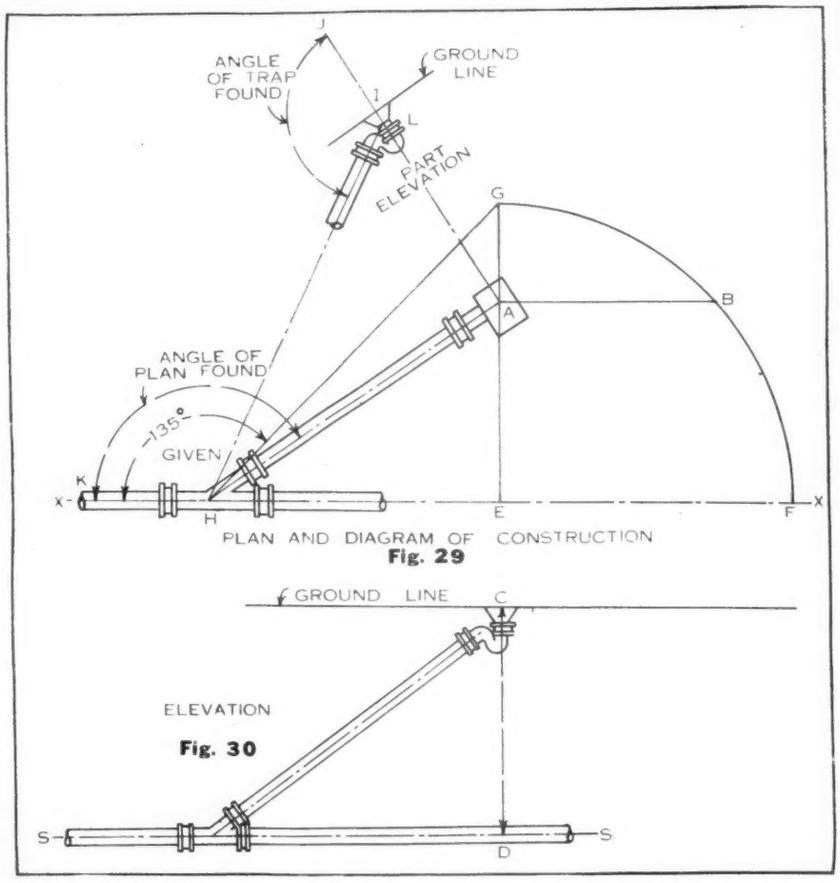
The line *X X*, Fig. 29, represents the main drain (level or nearly so) and *A* a point indicating the position of the trap at the ground level, the tail of the trap to be arranged to suit any level necessary. It is required to find the level of this trap, the true length of the branch and the point where the branch meets the main drain, working in at the junction a stock branch of 135 degrees.

Draw *A E* at right angles to *X X* and *A B* at right angles to *E A* making *A B* = *C D;* with center *E* and radius *E B*, draw a curve, *F B*, cutting *E A* produced at *G*.

Draw *G H* making the angle *G H K* equal to that of the stock branch, that is, 135 degrees.

Join *H A* and draw *A I* at right angles to *A H*, making *A I* = *C D*, Fig. 30, *C D* being the depth of the main drain from the ground level.

Draw in the trap at *L* and join the line of the trap with *H;* the angle *I L H* is the level of the trap; *H L I* is the true length of the branch, and *H* is the point where the branch meets the main pipe.



FIGS. 29 AND 30—THE GRAPHIC SOLUTION OF PROBLEM NO. 4

Number of Tuyeres in a Cupola

By W. J. Keep

Question:—I would like to know the number of tuyeres required for a cupola 60 inches inside diameter. Also kindly advise what size the tuyeres should be to obtain the best results in making machinery castings and how high they should be from the bottom plate of the cupola. I would also like to know what number and size would be best for a cupola 40 inches inside diameter and what should be the melting capacity per hour?

Answer:—The tuyeres should be as nearly continuous on the inside of the lining as they can be made. Between each tuyere leave sufficient space for a fire brick, or approximately 5 inches, and in large cupolas a space for two bricks can be allowed. Make the inside of the tuyere 4 inches high and the number will depend upon the openings in the shell. The bottom of the tuyeres should be inclined upwardly toward the shell so that any iron and slag entering will not run out. It is advisable to have as many tuyeres in the cupola as possible, since the charges and the slag will close them to some extent. The height of the tuyeres above the sand bottom should not be less than 12 inches and as much higher as your work requires. For machinery castings the tuyeres sometimes are 3 feet or more above the bottom, since for large work it is necessary to accumulate sufficient iron in the receiving ladles and in the cupola to pour the heaviest casting. The capacity of a 40-inch cupola is about six tons per hour.

Acid-Resisting Metal

By W. J. Keep

Question:—What would be a good acid-resisting metal for large pump chambers weighing 5,000 to 6,000 pounds?

Answer:—According to John Jermain Porter, in a paper presented before the American Foundrymen's Association several years ago, the mixture should analyze as follows: Total carbon, 3 to 3.50 per cent; silicon, 1 to 2 per cent; sulphur, under 0.05 per cent; phosphorus, under 0.40 per cent, and manganese, 1 to 1.50 per cent.

Mounting Patterns for Molding Machine Work

The Relative Value of Metal and Wood Patterns is Considered and Short-Cuts Are Presented That Reduce Costs

By E I Chase

SEVERAL points of interest are connected with making patterns for machine molding which are of no little importance to the foundryman. Without correctly made patterns, properly plated, the machine operator cannot reach a maximum output.

First, where a shop has an appreciable number and assortment of machines, it must be decided which type of machine is best adapted to the job in hand. In doing this it is well to consider from the design of the part, the number of castings to be produced, the cost and what material is best suited for the patterns. Split wood patterns made for ordinary molding are disappointing in results when put on plates because of their liability to bruise or chip in the process of peaning. Wherever possible, a cast iron pattern should be given first choice, but it has one drawback in not taking the solder well. A considerable amount of soldering is sometimes necessary, especially where the pattern is subject to numerous alterations and retouching after it is finished.

Second, consideration should be given to brass patterns; they are desirable, but wear faster and are more easily marred and dented than those made of iron. White metal patterns are in demand for rush jobs and a limited production; they are easily filed, soldered and fitted. For patterns of good weight and size they tie up considerable money. They are softer than brass and wear faster. The best thing that can be said of aluminum patterns is that they are light, and especially for very large jobs such as automobile engine bases, this property has great advantages. As a pattern material, however, it has several faults. Aluminum is hard to solder, has a high and inconsistent shrinkage, is soft and no aluminum solder will hold pieces on patterns when used for any length of time on jar-ramming machines or where a vibrator is used. I have made aluminum pattern plates with the patterns cast integral with the plate. After some little experimenting, we rammed the pattern castings in a tightly pinned wooden flask, separating the cope and drag with a ⅜-inch planed iron plate, having the outline of the pattern plate cut out. This was used to chill the outside, and the profile of the cut-out was made with a five-degree bevel to permit the aluminum cast plate to be extracted easily and without bending. Before closing the mold, the parting was carefully thumbed to make a fillet where the pattern joined the plate, to prevent shrinkage and consequent undercut. In spite of this care, however, the plates were unsatisfactory, principally because the center was thinner than the outer margin, notwithstanding the use of risers to feed it. The resulting plates might do where a variation in casting thickness could be overlooked, but as both cope and drag, rammed from these plates, had a convex surface of from 1/64 to 1/32-inch, the mold would be liable to crush and distort the castings. It is only fair to state, however, that many shops, especially stove foundries, have solved many of the difficulties of making these plates and use them extensively. It is possible that the trouble encountered by us was due to making the plates too thick. Of course, the patterns must be made suitable for the work for which they are intended and the machines on which they are to be mounted, and in the case of a straight parting line, this is easily accomplished.

Three-Part Mold or Cover Core

Another point to be considered is whether, when the design of the pattern requires two partings, it is better to make it a cope, cheek and drag job, or to use a cover core instead. The employment of cover cores is less expensive, and they insure a greater output of molds. Deciding this point is a matter of experience and judgment, and the policy of the foundry for which the pattern is made also is a controlling factor. Where loose bosses or brackets are to be taken care of, cores either must be provided to cover them, or, where possible, they should be used as drawbacks to be withdrawn from the sand into the pattern after ramming is finished. This can be accomplished by suitable levers or screws located underneath the pattern plate, and connected inside of the pattern by slides or cams, with sufficient throw to draw them clear of the mold. These drawback pieces must fit practically sand-tight, but loose enough not to jam as a result of ramming. It is possible, where there is sufficient inside pattern room, to fit three or four drawbacks to one cam located parallel to the pattern plate, so that by one motion of the lever or screw, they may be drawn in simultaneously. It might be well to state that these loose pieces should be withdrawn after all rapping on the plate is completed and when the pattern plate is to be raised from the flask.

Frequently, a boss projecting from the pattern may be cared for by leaving it loose and fastening it to the pattern, either with wires loosely fitted to holes drilled in the boss, or preferably by attaching it to the pattern with dovetails. Where dovetails are used, they should have a good taper lengthwise, so as to leave the pattern easily as it is drawn from the flask. The fastening of bosses to the pattern by loose wires is not to be recommended on account of the liability to ram out of position after the wires are withdrawn; sometimes they may be used for a limited output of castings. Any method of holding bosses which is not positive is liable to be unsatisfactory. The more mechanical the method, the more foolproof it is.

Some patterns must be made with an irregular parting, which will necessitate pockets of green sand in the drag or cope. In such a case it is desirable to give the sides of these pockets all the draft possible, not less than 30-degrees, though more is preferable, on account of the liability to shave or crush the sand when closing-on the cope. Besides giving good draft to these pockets, they should have all the spread possible, as the narrow pocket is more liable to drop than one given more width. Large draft on pockets is essential on patterns used on jolt machines, as it tends to prevent the cracking of sand which happens when the sides of the pocket form a more acute angle. Also, sharp edges should be avoided, and the patternmaker can save considerable after-work by watching where to make round corners and fillets. In Fig. 1, the pocket of sand at *X* is more liable to drop or crush outwardly into the mold, than the one at *Y*.

A good way to take care of these pockets is by screwing pads to the plate under the projecting parts of the pattern and giving these pads all the draft and spread possible; then, after

Presented at the Atlantic City meeting of the American Foundrymen's Association.

removing this half of the pattern and securing the cope and drag plates together, babbitt metal can be poured through holes drilled in the bottom of the corresponding plate. If this is well done and the plates have been previously heated, the shrinkage of the babbitt does not affect the parting line of sand in the drag and cope. This is a cheap, quick, and the best method of accomplishing the fitting of cope and drag plates, as the pad can be easily worked on and the corresponding pocket is automatically fitted by the melted babbitt. Plates fitted in this manner have given a production of 15,000 to 20,000 castings without showing appreciable wear.

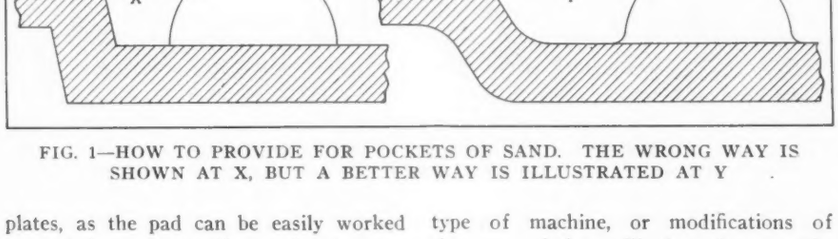


FIG. 1—HOW TO PROVIDE FOR POCKETS OF SAND. THE WRONG WAY IS SHOWN AT X, BUT A BETTER WAY IS ILLUSTRATED AT Y

Before pouring the babbitt, plenty of anchor holes must be drilled in the plate to secure the babbitt and to prevent it from loosening by vibration or jar-ramming. Again, some patterns require an irregularly-planed plate; for instance, a gas engine manifold with an angular outlet extending some distance beyond the plane of parting. Consequently, a flask specially made for the pattern is required, which is of no use for any other job. The cope and drag pattern plates must match each other perfectly and also the flasks. This kind of a job is expensive to fit up and is used only for a large output of a special casting. In connection with a pattern of this kind there usually is a crooked core box to match, which will need accurate core driers in order to keep the thickness of metal in the casting of uniform measurement. In specific cases, such as gas engine manifolds, we have found it necessary to use chaplets in both drag and cope to keep the core in position, and to put chaplet bosses on the pattern sufficiently large to burn to the chaplet. When the design of the casting permits, it is sometimes better to put the chaplet boss in the core, which does away with the operation of grinding it from the rough casting. Enough metal in the boss must be allowed to make the casting air-tight. We have drilled holes to the proper depth through bosses and have rammed the chaplets in position on the pattern. Also, we rammed small, round steel punchings, about 5/16-inch in diameter in the cores where the chaplets bear. Where the chaplet stems are small and no metal bearings are used for them in the core, it is not uncommon to find, that from the pressure of the metal and the softening of the core, the chaplet has penetrated the core and has permitted it to be misplaced.

With reference to plating patterns for different types of molding machines, we must consider the size, shape and depth of pattern when deciding what type of machine to use. A deep pattern will necessitate a deep draw and would go well on the roll-over or stripping plate type of machine, or modifications of these; a choice will depend upon the shop for which the pattern is to be made. Again, heavy patterns need a power machine. For small squeezers, using flasks about 12 x 18 inches, the pattern can be put on a rolled steel plate, preferably not less than ¼-inch thick, to avoid springing in ramming, but we find it better to use a ⅜-inch aluminum plate, cut from rolled stock, to avoid planing, on account of the tendency of steel to rust and flake off, unless well looked after, especially where the plates are stored for a considerable period between orders. These plates must be carefully drilled with a jig to insure fitting the flasks and the use of renewable hardened steel bushings is recommended. These are inserted in pattern plates to prevent undue wear and to preserve uniformity with original drilling when new bushings become necessary. Jigs for drilling flasks should not merely be a frame containing holes, but should be a finished piece of work worthy of the art of the toolmaker. Attention should be directed to the need of rigid exactness in drilling the flasks which should have the same hardened bushings, previously mentioned, and the wear on the flask pins should be watched. Several points should be noted to prevent poor castings: one is to have the pattern fit the plate tight without leaving an uneven parting which will result in broken edges of sand and a consequent ridge on the parting line on the casting; another is to have the fit of the core to the print exact, as a little crush will squeeze loose sand into the mold, resulting in a dirty casting. Gages used after setting the core, often show any misplacement of the core which would result in a thin shell in parts of the casting.

Mounting Small Patterns

When small patterns are mounted on these plates, they usually are located on both sides, for cope and drag, but in a great many cases where no cores are to be set, which would have to hang in the cope, half the pattern cost can be saved by putting both cope and drag halves of the pattern on one side of the plate. Patterns on one side of the plate are especially suitable for jar-ramming machines. This practice is not recommended, however, where there are a large number of small patterns in a flask, on account of the liability to ram away, and also, a very small shift looks unusually large on a small casting. If the pattern plate and the flasks do not have hardened steel bushings, a small shift can easily be doubled in size. This method requires the accurate laying-out of the patterns on the plate and special gating, since whatever is rammed in the drag appears also in the cope. Occasionally a gate is laid loose on the plate while ramming the drag and is removed while ramming the cope. However, this is not good practice, as there is always loose sand left where the gate joins the casting. In looking over sample castings from patterns mounted on one side of a plate, care should be exercised in condemning the pattern for shifts, *especially* on small pieces with a considerable number in a flask. Any shift showing on one side of the center line of the flask in the drag side of the casting will show correspondingly on the other side in the cope, and it is sometimes puzzling to determine the cause when shifts show otherwise. These shifts may be attributed to several causes such as ramming-away, weak flasks, loose flask pins, or sagging caused by too soft ramming when the cope is set on edge

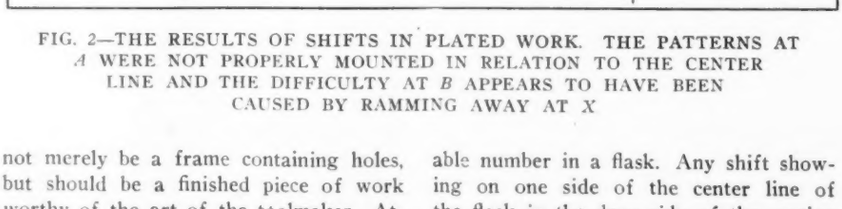


FIG. 2—THE RESULTS OF SHIFTS IN PLATED WORK. THE PATTERNS AT *A* WERE NOT PROPERLY MOUNTED IN RELATION TO THE CENTER LINE AND THE DIFFICULTY AT *B* APPEARS TO HAVE BEEN CAUSED BY RAMMING AWAY AT *X*

for blowing out the sprue, and in snap flask work, by carelessness in putting on jackets.

In Fig. 2, at *A*, it would seem that the patterns were not mounted properly in relation to the center line and the difficulty at *B* appears to have been caused by ramming-away at *X*. This indicates that the patternmaker should allow all the draft possible on plated patterns, and should avoid sharp corners, especially where core prints and pattern meet.

In the latter instance I recommended a fillet in most cases as it is more desirable to grind off a slight fin than to have a core crush in the mold, and thus get a dirty casting. Where patterns are put on one side of the plate for both cope and drag, they may be laid out by templates, by center lines and by paper. Where there are only one or two patterns in a flask, I prefer working by center lines, although templates may be used. The most commonly used template is a metal plate about ⅛-inch thick, drilled to match dowel pin holes in the drag halves of patterns and reversed on flask pins to drill the other side of the center line of the plate for the cope halves.

Mounting Number of Patterns on a Plate

When mounting a large number of patterns on a plate, the cheapest and quickest way is by means of paper. The paper should be suitable for the work and very good results are obtained with gasket paper, about 0.015-inch thick. This method consists in plating one-half of the patterns on one side of the center line and then removing the patterns and replating them with the paper underneath. With a sharp, pointed knife, cut carefully around the patterns and reverse on the flask pins and the other halves of the patterns will fit in the outlines while the screw holes are marked and prick-punched. Exercising care in cutting the paper and drilling the plate, accurate work will result. When the patterns have been screwed to the plate it is well to drill through both patterns and plate for close fitting dowel pins, to prevent shifting. The patterns, in all cases, must be securely fastened to the plate, preferably by screws, as rivets will work loose. When we consider large patterns that are heavy enough to necessitate the use of roll-over machines, we usually mount cope and drag on separate plates using two machines side by side. In some instances, where the output, as in a case of this kind, is large, we use a battery of machines making the same casting. It is advisable to put a distinguishing mark on each pattern for identification purposes.

A specific example of this is a group of six gas engine cylinder drags served by three cope patterns with three sets of core boxes interchangeable for all patterns. In plating these patterns we found it advisable to use templates to insure the matching of the cope and drag plates. In this instance it was necessary to put distinguishing marks not only on the cope and drag patterns, but also in the several core boxes. It will be found good practice to make the core fit the drag pattern accurately in length, and to make the cope prints from 1/16 to ⅛-inch longer, to prevent shaving when closing the mold. When using a jar or jolt-ramming machine, it is advisable to fasten the pattern securely to prevent loosening and consequent poor work.

Regarding stripping plate machines, all probably are familiar with the method of plating patterns and making a babbitt margin all around the pattern. These machines are principally used for gears and similar special castings where very little fin is allowable on account of the undesirability of grinding it off. The three-part flask is not generally used in connection with molding machine practice. It can be employed equally as well as the plain two-part flask, but the cheek must be drilled perfectly in line on the drag and cope side, and this can best be accomplished by drilling all holes at one setting in a specially-designed jig. The cope, cheek and drag *must* be planned, or ground, to fit, as otherwise poor work will result. Often in three-part flask work, only one machine is necessary, as both cope and drag may be shallow enough to be rammed on dummy plates and lifted off without rolling over. Sometimes we can avoid using a three-part flask by placing a cover core over the part not possible to draw with the pattern, and if cores are to be set extending below the cheek, a much better core seat is made than with green sand.

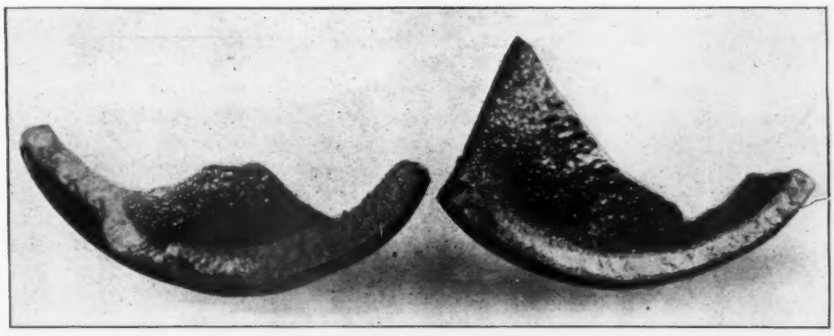
The points about draft, fillets and avoiding sharp corners are applicable to the core box as well as to the pattern and we find it profitable to mount the large core boxes on rock-over machines to insure both speed and accuracy. In a foundry where several different makes and sizes of machines are used, it is advisable, when practicable, to make the pattern plates to fit two or more machines. This will permit continuing work in case of breakdown or of being obliged to give up a certain machine for a special job and will make a greater number of machines available for each job.

Most squeezers are suitable for patterns mounted on either one or both sides of plates, while several small jar-ramming and power squeeze machines can only be used with patterns on one side of the plate. When we come to consider large rock-over or roll-over machines, we usually must mount cope and drag on separate plates, and as previously stated, we must try to arrange their use on several different styles or sizes. In the foregoing statement I should have included the designing of plates to fit two or more types of machines where possible, as well as more than one size of the same type. We have some plates fitted for squeezers, two sizes of rock-over machines and one roll-over machine, so in most cases we can use them on whatever machine is available for the work.

The White Core Returns

By W J Keep

QUESTION:—In your previous reply to our inquiry you advised us to use a better quality of pig iron, which was done, and the white core disappeared from the castings for a few days, but again we are troubled with the same difficulty. In the accompanying illustration are shown fragments of a hand grenade casting which is spherical, 3 inches in diameter and cast four on a sprue. Do you think that this is caused

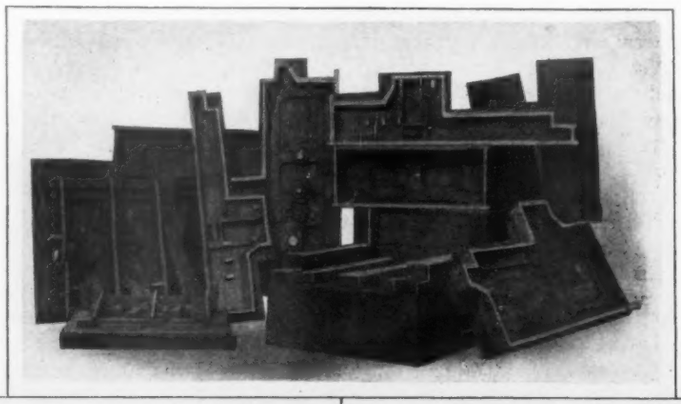


FRAGMENTS OF A HAND GRENADE CASTING SHOWING THE WHITE CORE

by the gates being too large for the runner and not being kept full while pouring, which permits a small quantity of white iron to enter the mold, finishing at the end of the pouring with good gray iron? We have tried all methods of gating and we have changed our mixture repeatedly, but still we are unable to overcome this difficulty.

Answer:—This is a very interesting problem and I have frequently explained the cause of this trouble and the remedy. The cause is purely mechanical, but cannot be traced to the molds. The bottom of the cupola is wet when the first melted iron collects on it, causing the first iron to boil. The molders begin to take iron with the linings of their ladles still fresh and when iron is caught from the cupola it boils again. This may not be due to moisture perhaps, but is caused by the gases formed by the molten iron coming in contact with the ladle lining. It is the custom for a second molder to take the same iron into his green ladle to dry it. If this iron is poured into the pig bed no harm results, but the second molder knows that he can use the iron and he pours it into his mold, thereby getting an extra dip. Under certain conditions this iron, after such treatment, will produce a white core surrounded by gray iron, but this is not chilled iron.

The remedy is to break up this routine which produced the peculiar iron. By heating the cupolas earlier and using more fuel, the cupola bottom will not cause the melted iron to boil so hard and will stop the trouble. Since only the first 500 or 1,000 pounds taken out of the cupola produce such castings, the second dip around will be entirely free from the trouble because the ladles have become dry by that time and, therefore, it is advisable to pour the first 200 or 300 pounds, or perhaps even a little more, into castings in which such iron will do no harm. Also, it might be advisable to compel the molders to pig iron that has been used for drying the ladles. As soon as the iron that has boiled in the cupola has been tapped, the trouble stops. If you will discount all work that has a white core, the molders soon will stop making it.



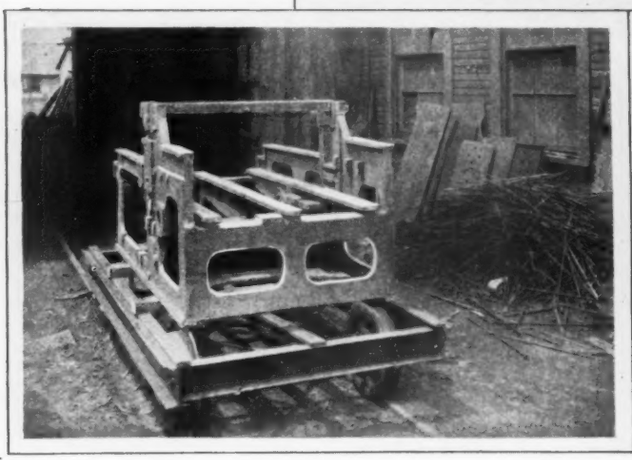


FIG. 1—PATTERN AND CORE BOXES

FIG. 2—ONE-PIECE PRINTING PRESS FRAME WEIGHING 19,000 POUNDS

FIG. 3—MOLD FOR PRINTING PRESS FRAME SHOWING METHOD OF SETTING CORES

A One-Piece Printing Press Frame

By D. O. Barrett

The Delphos Printing Press Co., Delphos, O., has developed an interesting one-piece printing press bed in the casting of which some unusual foundry problems are encountered. The entire bed, including sides and ends, as well as the center bars, is cast in one piece, the casting being 46 inches wide, 72 inches long and 36 inches high, weighing approximately 19,000 pounds. The finished casting, as it comes from the cleaning room of the foundry, is shown in Fig. 2. Fig. 1 shows the pattern surrounded by the largest of several core boxes utilized in the production of the casting, which is made entirely in cores. A plain pattern is used. The casting is poured in an inverted position in a pit, the sand forming the bed being tucked underneath the pattern. In order that this operation may be performed conveniently, the pit is made sufficiently wide to permit a molder to enter on either side of the pattern. The pit, with the cores partially set, is shown in Fig. 3. The pattern comes level with the floors so that a flat cope is used simply for covering purposes. After all the cores have been set and properly located, sand is rammed between the outer edges of the cores and the walls of the pit to eliminate the possibility of the cores shifting or swelling. Fig. 3 shows one of the center cores being lowered into place by the crane. The method of gating is also clearly shown at the left in this illustration. The average time for making up a complete set of cores is 32 hours, and the direct molding time is approximately 25 hours. The castings are made at the plant of the Power Mfg. Co., Lima, O.

The total shipments of iron ore from the mines of the United States in 1915 are estimated at 55,000,000 gross tons, compared with 39,714,280 tons in 1914, an increase of more than 38 per cent. Of this output 46,318,804 tons were shipped by boat from the Lake Superior district. The latter shipments showed an increase of nearly 44.7 per cent.

The U. S. Molding Machine Co., Cleveland, is sending to the trade a handsome monthly calendar.

Science Testing of Malleable and Cast Steel

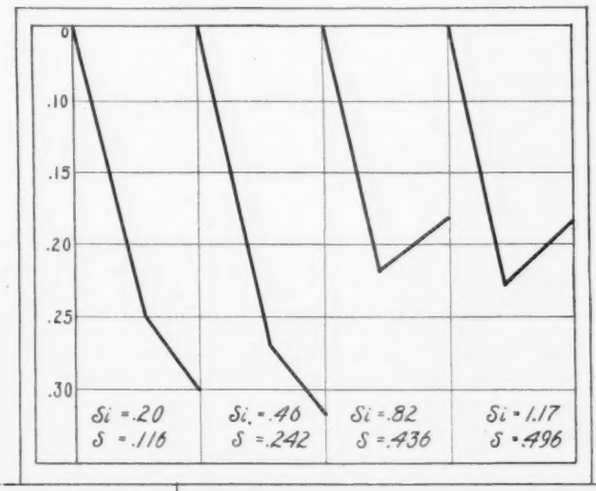
An English Viewpoint on the Manufacture of Small Castings, With Chemical, Physical and Metallographic Side-Lights

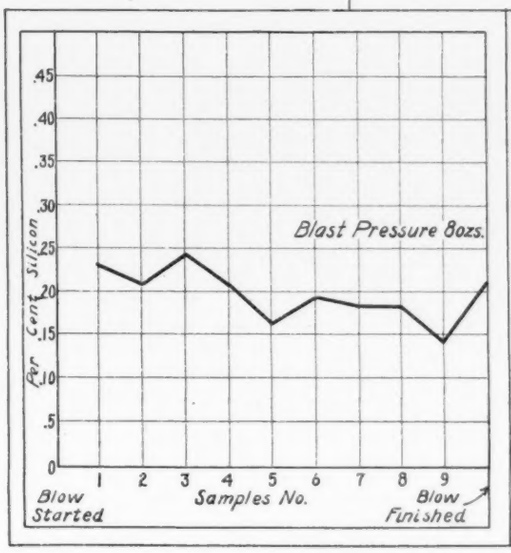
By Andrew Harley

BROADLY speaking, the subject in which we are interested is the production of light castings in malleable iron and mild steel. My experience in recent years has been in the production of castings for the motor and cycle trade, and what I have to say naturally applies more particularly to this class of work. Such as it is, the field is a vast one and it is obviously impossible in the time at my disposal to cover the ground even in the most general manner. I therefore propose to mention a few general considerations, to deal with the production of molten metal and to discuss a series of tests which I have made on cast malleable and cast steel. Among foundrymen sharp differences of opinion exist concerning the best methods of production, and among both foundrymen and engineers there is considerable diversity of opinion as to the relative merits of the two metals as applied to various purposes. With regard to the former, these differences of opinion occur at every stage of production. One man puts his faith in certain brands of iron, while another may not worry about the particular brand if the analysis is according to his liking. One man will say that good malleable cannot be made with cupola metal, another will affirm that he is doing it. On the molding floor one man favors the use of chills, another places a feeder wherever he thinks it necessary, and sometimes where it is not. In regard to annealing malleable, no two men think alike. One man will swear by round ovens, another will swear at them. One man believes in soaking; another will ask how it is possible under the present restrictions.

With regard to differences of opinion that exist among foundrymen and engineers as to the relative values of the two metals, the last section of this paper will have a more direct bearing on this question. In the meantime I will refer to a paper recently published in *The Engineer*. The author, an engineer, advocated the employment of malleable iron in preference to cast steel for tractor road wheels. The suitability of the metal was not only emphasized, but a point was made of the greater ease and lower cost of production. My experience would lead me to differ with the writer on both counts. First, I have my doubts as to whether malleable is at all suitable for such a job, and, secondly, I am decidedly of the opinion that in this particular instance a steel casting of high quality could be produced more cheaply than a malleable casting.

The cost, or rather selling price, has a good deal to do with the question of quality. The cult of cheapness can be carried too far. The mal-





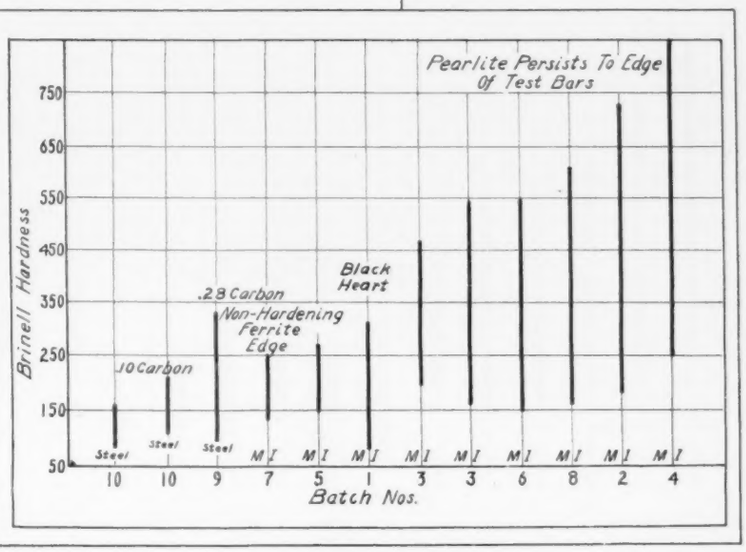


FIG. 1—CHART SHOWING THE SHRINKAGE OF MALLEABLE IRON

FIG. 2—LOSS OF SILICON, CUPOLA MELTED WHITE IRON

FIG. 3—INCREASE IN HARDNESS PRODUCED BY QUENCHING SPECIMENS FROM 820 DEGREES CENT.

An address delivered before the Birmingham branch of the British Foundrymen's Association, Dec. 4, 1915.

leable trade particularly has suffered from this. The cutting of prices has not always been accompanied by a reduction in cost due to improved methods of production. More often the reduction in cost has been accomplished by the use of inferior material. The buyer is not free from blame, however. With too many, orders are placed at the lowest price, irrespective of quality. They have acted on the principle that "malleable iron is malleable iron all the world over". People sometimes get what they pay for.

Improved Quality

We must constantly strive to cheapen production, but we must also strive to improve the quality of the product. The processes involved must be carefully studied, and this can only be done by the use of scientific equipment, handled by men with some scientific training. Much unnecessary waste would be avoided, provided the management is competent to apply the scientific information in a practical manner.

There is another factor influencing foundry costs, and that is the influence of design. In fact, the design not only influences cost, but very often the quality of the casting. The foundryman should be consulted in this matter and in an efficiently managed concern this is done, and any alterations suggested are made where possible. Even when the best has been done with a design, in most cases there will still be plenty to engage the foundryman's skill.

With regard to the relative cost of malleable and steel castings it is difficult to give a definite answer. For very light work, say under ⅜-inch section, it tells against steel; over this section it favors steel. This is necessarily a rough generalization as obviously much depends on the size and shape of the casting.

The actual foundry cost is not the only point to take into consideration. At present greater machining allowances are required for steel. On the other hand, the greater strength of steel allows a relatively lighter casting to be used.

For certain classes of work, such as cycle parts, a fine skin is absolutely essential, as the majority of such parts have not only a very small machining allowance, but subsequently have to be enameled or plated whereby any irregularity on the surface would be intensified. Malleable, therefore, is in favor for such work, but progress is being made with steel in this respect.

Broadly speaking, the particular melting method adopted is governed by the class of work and the output to be handled. Certain prime essentials are necessary in every furnace melting any metal on a commercial scale. All foundrymen are acutely aware of what these essentials are. The metal must be of ample fluidity, correct and regular composition and produced at a reasonable cost.

Dealing with malleable first, the three principal types of furnaces in use are the crucible, reverberatory or air furnace and the cupola. The air furnace is used chiefly in the production of black heart malleable with which we are not much concerned. In the production of Reaumur malleable, the cupola and crucible furnace are almost universally used. Where the output justifies it, the cupola should have preference. The crucible furnace usually is credited with giving better quality metal than the cupola. This may be so, although it is not altogether obvious why it should be so.

It may be due to the fact that the percentages of carbon and silicon are not subject to so much alteration in the process of melting. On the other hand, it has always seemed to me that variations in the iron, as delivered, were more likely to be perpetuated in the molten state when melted in the crucible furnace. The cupola can be operated more economically, the metal can be obtained in a higher state of fluidity, and I am convinced that by taking certain precautions, metal can be obtained which is much more regular in composition.

Uniform Composition of Hard Iron

In the production of malleable, a uniform composition in the hard state is of the utmost importance. Irregularities in the hard metal lead to most of the difficulties in annealing. I do not advocate any particular analysis as being right and all the others wrong. What I want to emphasize is, that, having decided on what is the most suitable composition for your class of work, the furnace should give (within reasonable limits) molten metal of that composition throughout the melt. Any change in the metal must be intentional and known so that the castings subsequently can be graded and given the annealing treatment most suitable to their composition.

In the following I will describe as briefly as possible the means which I have found it necessary to adopt to obtain this control. For the sake of brevity I must make certain assumptions. I must assume the existence of a laboratory or facilities for obtaining analyses. I also assume that the furnace is fairly correct in its proportions and that there is uniform supply of air at the correct pressure. In other words I am confining myself altogether to the raw material which goes into the furnace. The pig iron must be bought to specification and should be adequately checked. We have found it advantageous to give each separate consignment a reference number. This number is not only attached to the heap of pig iron in the yard, but is used in all subsequent records. A separate stock card is filled out for each consignment. This card shows the analysis and also the usage.

Importance of Grading Scrap

Scrap must be graded according to analysis, the silicon content being sufficient, as a rule. The grading of scrap is rather important, although it might be inferred that if the molten iron is regular in composition, the scrap will be so also. If the scrap is melted daily, however, the composition of the metal will change, due to the fact that a certain portion of the metal is, of necessity, melted over and over again. If one could be sure that the whole of the previous day's "git and runner" metal was obliging enough to make its way into the next day's castings, then everything would be all right. As it is, to keep perfectly straight, small daily adjustments would be necessary in the pig used. To avoid this, the scrap from one mix is accumulated so long as that particular mix is in use. If the silicon has been kept fairly regular, this heap of scrap can be incorporated in the mix at a subsequent date, with the comfortable feeling that you know what you are using. If the silicon content has altered radically through some unforseen cause, this is quickly known by the daily analysis of the cast metal and both castings and scrap, with this altered silicon, are separated from the normal metal.

Coke of the best quality must be used. The sulphur particularly should be as low as possible. Ordinary English malleable pig irons usually contain a pretty high percentage of this element and it is undesirable to increase this by any appreciable amount. The coke also should be uniform physically. The coke we are using at present shows the following average composition: Fixed carbon, 93.65 per cent; ash, 5.65 per cent, and sulphur, 0.70 per cent.

Definite knowledge must be acquired with regard to the inevitable changes that take place in the composition of the metal during the melting process. These changes must be allowed for. The elements affected are carbon, silicon and sulphur. The amounts of these elements present and also the relative proportions, largely determine the annealing treatment required. We have found that these losses and gains vary

LENGTHS OF SIDES OF POLYGONS

By S. L. Cook.

In Data Sheets Nos. 197 and 198, published in the November, 1915 issue of THE FOUNDRY, tables were presented giving the correct diameters for circles circumscribing squares, hexagons and octagons of various sizes ranging from 1-16 to 6 inches across flats. In order to lay out these polygons on a pattern with a pair of dividers it is necessary also to know the length of one side of the polygon. These data are given in the accompanying tables.

Distance across flats, inches.	Length for squares, inches.	Length for hexagons, inches.	Length for octagons, inches.	Distance across flats, inches.	Length for squares, inches.	Length for hexagons, inches.	Length for octagons, inches.
1/16	1/16	3/32	3/32	1¼	1¼	33/32	33/64
1/8	1/8	6/64	6/64	1 1/16	1 1/16	¾	25/64
3/16	3/16	7/64	7/64	1⅜	1⅜	35/32	7/8
¼	¼	8/64	8/64	1 7/16	1 7/16	37/32	29/32
5/16	5/16	9/64	3/8	1½	1½	39/32	15/16
3/8	3/8	10/64	10/64	1 9/16	1 9/16	41/32	41/64
7/16	7/16	¼	9/32	1⅝	1⅝	43/32	43/64
½	½	17/64	11/32	1 11/16	1 11/16	45/32	45/64
9/16	9/16	18/64	12/32	1¾	1¾	1 3/64	23/32
5/8	5/8	21/64	14/32	1 13/16	1 13/16	1 5/64	¾
11/16	11/16	25/64	15/32	1⅞	1⅞	1 7/64	25/32
¾	¾	7/16	7/16	1 15/16	1 15/16	1 9/64	51/64
13/16	13/16	15/32	1/2	2	2	1 11/32	53/64
7/8	7/8	1/2	17/32	2 1/16	2 1/16	1 13/64	55/64
15/16	15/16	17/32	18/32	2⅛	2⅛	1 15/32	7/8
1	1	37/64	19/32	2 3/16	2 3/16	1 17/64	29/32
1 1/16	1 1/16	39/64	5/8	2¼	2¼	1 19/64	15/16
1⅛	1⅛	41/64	21/32	2 5/16	2 5/16	1 21/64	31/64
1 3/16	1 3/16	11/16	22/32	2⅜	2⅜	1⅜	63/64

(*Continued on Data Sheet No.* 204.)

LENGTHS OF SIDES OF POLYGONS

By S. L. Cook.

(*Continued from Data Sheet No.* 203.)

Distance across flats, inches.	Length for squares, inches.	Length for hexagons, inches.	Length for octagons, inches.	Distance across flats, inches.	Length for squares, inches.	Length for hexagons, inches.	Length for octagons, inches.
2 1/16	2 1/16	1 33/64	1 1/64	4¼	4¼	2 33/64	1 41/64
2½	2½	1 7/16	1 3/32	4 1/16	4 1/16	2 41/64	1 39/64
2 1/16	2 1/16	1 31/64	1 1/16	4⅜	4⅜	2 47/64	1 43/64
2 5/16	2 5/16	1 33/64	1 5/32	4 7/16	4 7/16	2 49/64	1 47/64
2 7/16	2 7/16	1 37/64	1 7/64	4½	4½	2 53/64	1 51/64
2¾	2¾	1 43/64	1 9/64	4 9/16	4 9/16	2 61/64	1 57/64
2 13/16	2 13/16	1 5/8	1 11/64	4 5/8	4 5/8	2 63/64	1 59/64
2⅞	2⅞	1 23/32	1 3/16	4 11/16	4 11/16	2 65/64	1 61/64
2 15/16	2 15/16	1 47/64	1 7/32	4¾	4¾	2¾	1 63/64
3	3	1 47/64	1 15/64	4 13/16	4 13/16	2 69/64	2
3 1/16	3 1/16	1 49/64	1 17/64	4⅞	4⅞	2 1/16	2 1/64
3⅛	3⅛	1 51/64	1 9/32	4 15/16	4 15/16	2 71/64	2 3/64
3 3/16	3 3/16	1 53/64	1 5/16	5	5	2 73/64	2 1/16
3¼	3¼	1⅞	1 11/32	5 1/16	5 1/16	2 77/64	2 5/64
3 5/16	3 5/16	1 29/32	1 3/8	5⅛	5⅛	2 79/64	2⅛
3⅜	3⅜	1 61/64	1 25/64	5 3/16	5 3/16	3	2 7/64
3 7/16	3 7/16	1 63/64	1 27/64	5¼	5¼	3 1/32	2 9/64
3½	3½	2 1/64	1 29/64	5 5/16	5 5/16	3 1/16	2 11/64
3 9/16	3 9/16	2 1/16	1 31/64	5⅜	5⅜	3 3/64	2 3/32
3⅝	3⅝	2 3/32	1½	5 7/16	5 7/16	3 5/64	2¼
3 11/16	3 11/16	2⅛	1 37/64	5½	5½	3 7/64	2 5/32
3¾	3¾	2 11/64	1 35/64	5 9/16	5 9/16	3 9/64	2 13/64
3 13/16	3 13/16	2 13/64	1 37/64	5⅝	5⅝	3¼	2 7/32
3⅞	3⅞	2 15/64	1 39/64	5 11/16	5 11/16	3 5/32	2 15/64
3 15/16	3 15/16	2 17/64	1⅝	5¾	5¾	3 7/16	2⅜
4	4	2 7/16	1 41/64	5 13/16	5 13/16	3 23/64	2 33/64
4 1/16	4 1/16	2 31/64	1 11/16	5⅞	5⅞	3 25/64	2 7/16
4⅛	4⅛	2⅜	1 43/64	5 15/16	5 15/16	3 27/64	2 39/64
4 3/16	4 3/16	2 37/64	1 47/64	6	6	3 1/2	2 31/64

Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note-book form.

THE FOUNDRY DATA SHEET, FEBRUARY, 1916

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

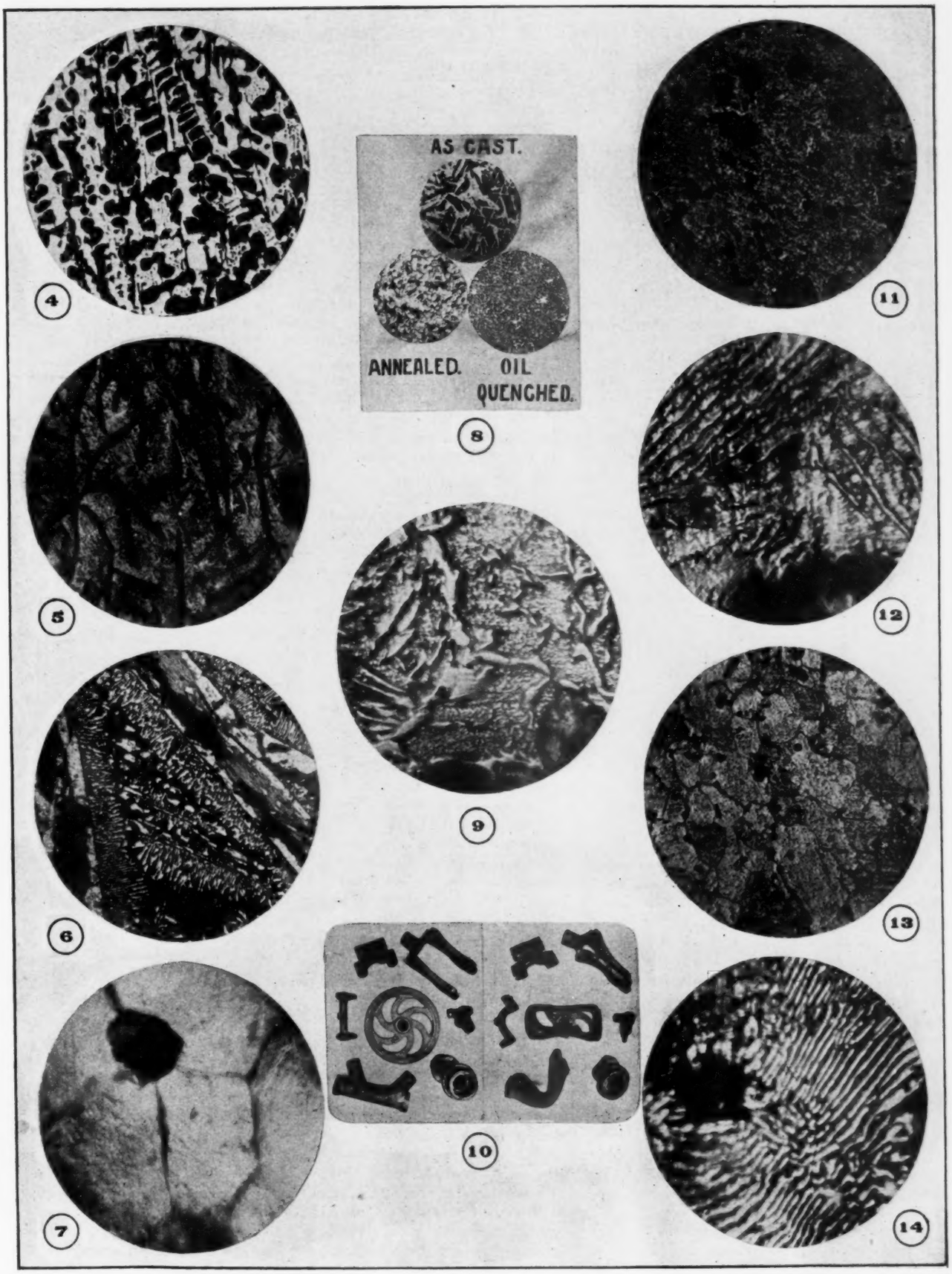


FIG. 4—PHOTOMICROGRAPH OF WHITE PIG IRON; FIG. 5—PHOTOMICROGRAPH OF PIG IRON USED FOR STEEL MAKING; FIG. 6—PHOTOMICROGRAPH OF SPIEGELEISEN; FIG. 7—ENLARGED PHOTOMICROGRAPH OF *C*, FIG. 15; FIG. 8—EFFECT OF HEAT TREATMENT ON MILD STEEL; FIG. 9—ENLARGED PHOTOMICROGRAPH OF *C*, FIG. 18; FIG. 10—STEEL CASTINGS AS MADE AND DISTORTED TO SHOW DUCTILITY; FIG. 11—ENLARGED PHOTOMICROGRAPH OF *B*, FIG. 21; FIG. 12—ENLARGED PHOTOMICROGRAPH OF *C*, FIG. 21; FIG. 13—ENLARGED PHOTOMICROGRAPH OF *A*, FIG. 22; FIG. 14—ENLARGED PHOTOMICROGRAPH OF *C*, FIG. 23

throughout a heat. With silicon for instance, the loss in our practice at the beginning would be 0.23 per cent. This would diminish fairly regularly until 0.14 per cent only was recorded. Then, just at the end, we got a sudden jump back to 0.21 per cent. Sulphur acts in much the same way. At the beginning we had an increase of 0.07 per cent, but toward the end this was reduced to 0.003 per cent.

The importance of good, hot metal of suitable and regular composition cannot be over emphasized. This applies to all metals, but particularly to malleable iron and cast steel, and expenditure to secure this is amply justified. It is the foundation on which a good casting is made possible. Neglect or carelessness in this direction renders all subsequent care and skill useless. Many of the troubles that are usually assigned to the defects in molding and coremaking really originate in defective melting. In casting malleable for instance, sears, cracks, draws and blowholes may be avoided to a considerable extent, but over and above all this, the successful annealing of malleable is only rendered possible by the metal being of suitable and regular composition.

Annealing Malleable Castings

The annealing of malleable requires a good deal of skill and experience, even when the hard metal is everything that it should be. There is no royal road to success in this process. Each man must work out his own salvation. The knowledge we acquire from others no doubt is useful, but the knowledge obtained from hard experience is the best.

The following observations on annealing are not advanced, therefore, as infallible *dicta*. They are, however, the result of practical experience and may be helpful to some who are engaged in this most difficult business. If I tried to sum up my views in one sentence on the metallurgical process of annealing, the sentence would run somewhat as follows: "Any process in which equilibrium is established and maintained between the breakdown of the cementite and the diffusion of the carbon towards the exterior is likely to give satisfactory results."

The precipitation of carbon is governed more by composition than anything else. Take the influence of silicon, for example. With low silicon metal of say 0.3 per cent, precipitation is retarded. With a high silicon metal, on the other hand, precipitation may take place too soon, or in other words, at too low a temperature. Very little carbon would be removed and a kind of black heart would be produced.

As Hatfield has pointed out, there are two phases of this annealing process: first, elimination of carbon; second, softening of the interior by precipitation of the annealing carbon. Each phase must be accomplished at the proper time by establishing equilibrium. The treatment necessary to obtain this equilibrium will vary with the composition. The most favorable period for the removal of carbon is the one just preceding actual precipitation. Where the composition of the iron is such that precipitation may take place at a low temperature, equilibrium must be established between the removal of the carbon and the return of the annealing carbon into solution.

The influence of silicon and sulphur should be considered together inasmuch as silicon favors the precipitation of carbon and sulphur retards it. It follows that the primary effect of either is modified by the relative amounts present. In fact, the influence of these constituents must be so regulated as to obtain the balance already mentioned between the rate of diffusion and the breakdown of the cementite. To illustrate this point, a low silicon metal of say 0.3 per cent which is quite annealable with 0.25 per cent of sulphur, is almost un-annealable with 0.5 per cent of sulphur. On the other hand, a higher silicon of say 0.75 per cent will give very indifferent results with low sulphur, the best results being obtained when associated with 0.45 per cent. These statements may not hold good where manganese is present to any extent.

In most Reaumur metal the percentage of manganese is very low, as it ought to be. In black heart you will often find from 0.4 to 0.5 per cent present. In the absence of sulphur this no doubt serves a useful purpose in retarding precipitation to some extent and enabling some carbon to be removed.

Many questions are always asked regarding the practical details in annealing. Sometimes these questions are not answered. I would say this, however, that all such practical details center in the problem I have been dealing with. The design of the oven naturally should give as even a distribution of heat as possible. There is no oven built in which the heat is quite evenly distributed, and I have often been thankful for this. With large ovens, there is generally a considerable variety of work, with varying sections. By exercising discretion in arranging the castings in the oven, a variety of work can be satisfactorily dealt with. Variations in the ore strength also are made to overcome this difficulty. Where there is a battery of smaller sized ovens, the castings can be more closely graded according to weight. A further advantage is that with such a battery, extensive delays are avoided. Ovens are at all stages of firing and unloading and an even flow in deliveries is secured. There are many advantages about such an arrangement, but one disadvantage is the somewhat higher cost of annealing.

If removal of carbon is too rapid, owing to excessive temperature and too strong ore, then the complaint known as *peeling* occurs. If the temperature is too low, or the ore too weak, then hardness results. With a medium silicon iron in a coal-fired oven, the time necessary for diffusion is usually obtained by damping down for the night or *soaking* as it is called, but similar treatment in a large gas-fired oven of say 10 tons capacity might not be satisfactory owing to the longer time such an oven holds its heat. In fact, removal of carbon may be taking place all through the night. In such a case the shutting down of the oven for 24 hours or so in the middle of the fire would prove advantageous. If a high silicon iron is used, the operation may be affected with a total fire after coming up to heat of 3½ days, even for the thickest section. In this period 1½ days would be spent in soaking or diffusing. The carbon removed is, of course, not very large, but for many purposes the malleable is quite satisfactory. If a better quality of iron is desired, the addition of two days to the firing time will produce the extra elimination of carbon which is necessary to give the superior quality to the material.

Advantages of Soaking

With reference to soaking, theoretically a continuous fire is no doubt quite possible, but practically we consider soaking advantageous. If the elimination of carbon is proceeding too vigorously, it allows equilibrium to be established.

The size and shape of the pans, strength of ore used, the temperature and time taken, all have to be adjusted to the one end, but it must be borne in mind that many such details are constantly changed, and necessarily so, according to the size, shape and composition of the castings.

If it is of any interest, I may mention that we use gas-fired round ovens. We make our own pans, and a useful thing to remember here is that a pan should be made of metal which resists annealing. In regard to ore, we use all strengths ranging from all black to 3 to 1. The analysis of good annealing ore should be approximately as follows: Ferric oxide, 84 to 90 per cent and silica, 8 to 13 per cent. Lime should be absent. Ferrous oxide should not be present, and anything more than 1 per cent should be objected to.

In the production of molten steel of

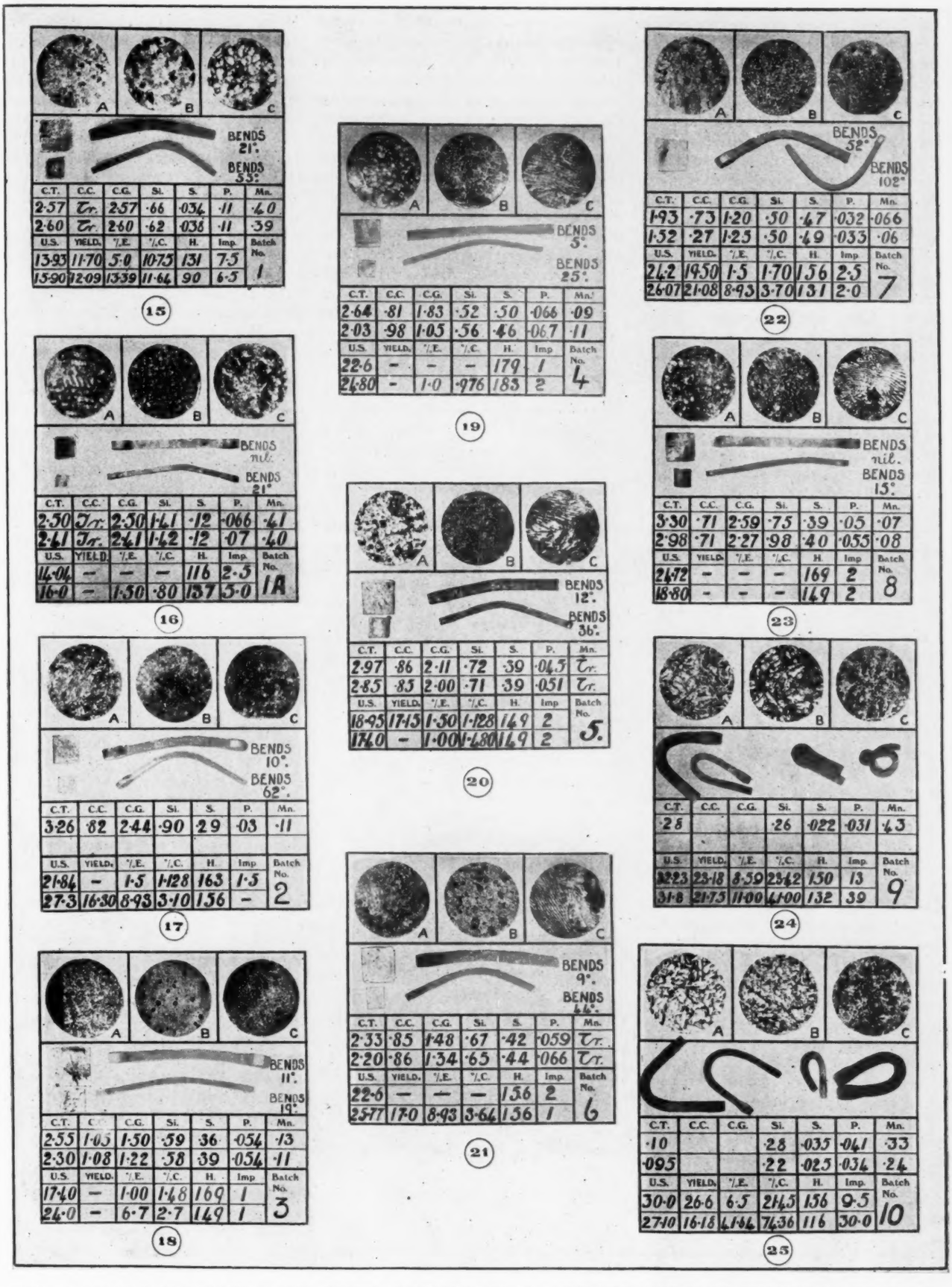


FIG. 15—SAMPLE OF ENGLISH BLACK HEART MALLEABLE; FIG. 16—ANOTHER SAMPLE OF ENGLISH BLACK HEART MALLEABLE; FIG. 17—SAMPLE OF NEUTRAL, BLACK HEART MALLEABLE; FIG. 18—SAMPLE OF REAUMUR MALLEABLE; FIG. 19—ANOTHER SAMPLE OF ENGLISH REAUMUR MALLEABLE; FIG. 20—SAMPLE OF HIGH SILICON REAUMUR MALLEABLE; FIGS. 21-23—SAMPLES OF ENGLISH REAUMUR MALLEABLE; FIG. 24—SAMPLE OF MILD CONVERTER STEEL; FIG. 25—SAMPLE OF MILD ELECTRIC STEEL

low carbon content, we are up against a much stiffer proposition than in the melting of either malleable iron or cast iron. It is only in comparatively recent years that anything like success has been achieved. In making this statement I am referring to mild steel capable of being run into light castings, many of them intricate in design. Furthermore, the molds are only skin-dried, as a rule.

It is interesting to compare the melting temperatures of gray and malleable iron and steel. Ordinary gray cast iron melts at about 1,150 degrees Cent.; malleable iron at approximately 1,250 degrees Cent. and mild steel, about 1,570 degrees Cent.

The pouring temperature, of course, is a different matter entirely. In the process I am about to describe where a bulk of about 1,200 pounds of molten steel has to be cast in one heat and into a large number of small molds, the temperature of the metal has to be very much higher. In fact this must be in the neighborhood of 1,900 degrees Cent. In other words, we require a margin which must be higher by at least 300 degrees Cent.

Steel Melting Furnaces

The general types of steel furnaces in use are the crucible, converter, open-hearth and electric. Each of these four divisions represents wide systems in which there are many varieties. The process of melting which I am about to describe involves the use of a converter of the stock type. The bessemer converter, of course, is the father of all such types.

The chief modifications are that the pig iron, instead of being melted in a cupola is melted in the converter. Also, instead of being blown from the bottom as in the bessemer converter, the metal is surface-blown. The surface-blown method also is used in the Tropenas furnace, but in this case the pig iron is melted in a cupola, as in the bessemer process.

Small capacity converters have been tried many times, but with varying success, the great difficulty being to obtain a metal of sufficient fluidity to cast the general run of light work in an automobile foundry. A larger capacity vessel would no doubt give somewhat hotter metal at the moment of pouring, but a proportionately larger number of molds would have to be poured and before the finish a larger proportion of the metal could not be cast satisfactorily. Where castings of a considerable variety in weight are handled, this trouble would be obviated to some extent by grading the work on the floor.

The melting of the charge in the vessel by means of an oil burner is an important factor in obtaining very hot steel. Before this operation is completed the lining has attained a very high temperature, thus conserving the heat created during the blow proper. Furthermore, the escaping heat during the melt is used to heat a regenerative chamber. The air is passed through this chamber when blowing and enters the vessel at a temperature of 300 degrees Cent.

What I have said about care in the selection of raw material for malleable melting applies equally to steel. In fact, more so, because I doubt very much whether it is possible to perform this job properly without knowing the exact composition of the pig iron and also making a carbon test for each melt. That is the minimum.

A typical analysis of pig iron to be used for conversion, follows: Total carbon, 3.88 per cent; combined carbon, 0.20 per cent; graphitic carbon, 3.68 per cent; silicon, 2.53 per cent; sulphur, 0.04 per cent; phosphorus, 0.04 per cent, and manganese, 1.10 per cent.

Consistently good results have been obtained from pig iron of this composition, the steel pouring hot to the finish. Slight variations in the silicon and manganese content are allowable. Furthermore, silicon should not drop below 2.3 per cent, or manganese 0.8 per cent if the molten steel is required to run very thin castings. The charge takes about two hours to melt and about 20 minutes to blow. The blast pressure for melting is about 1¼ pounds, and the pressure for blowing about 2½ pounds at first, afterwards increasing to 3 pounds.

Assuming that the blow is finished, the composition of the metal should be approximately as follows: Carbon, 0.1 per cent; silicon, trace; manganese, *nil*, and sulphur and phosphorus, 0.04 per cent.

The metal now has to be carburized and deoxidized. This is done by the addition of the mix. The composition after the additions should be approximately: carbon, 0.23 per cent; silicon, 0.2 to 0.3 per cent; manganese, 0.4 to 0.5 per cent; sulphur and phosphorus, 0.04 per cent.

The mix is made up from spiegel, silicon-spiegel and pig iron, the quantity of each needed being calculated to bring the composition up to the second analysis given.

Summary

Taking it all around, the difficulties in the way of producing mild steel castings are great, but much progress has been made in recent years. The manufacture of malleable is a much older business, but the progress made is not what it should be. Malleable iron has possibilities, but the trade suffers from a spirit of conservatism and secrecy. Looking through the various batches of malleable received, I have come to the conclusion that there is a tendency among modern malleable founders to use a higher silicon iron than was used in the earlier days. This may be due to the difficulty of obtaining irons with low sulphur. I do not think, however, that the ideal annealing process, required by the new conditions, has been obtained. The rapid decomposition of cementite into pearlite and graphite is not enough to make a good malleable casting and an effort should be made to understand more fully the annealing treatment required for metals of varied composition. With regard to steel, it cannot be denied that we have here a material much superior physically. Notwithstanding its terrible propensity for blow-holes, etc., and the many problems that confront the founder of mild steel castings, I am convinced that great developments will take place in this industry in the immediate future. In this development, the electric furnace will play an important part.

Shrinkage of Malleable Iron

In the accompanying illustrations, Fig. 1 is a graphic representation of the shrinkage of malleable iron. Most malleable founders have experienced difficulties from cracking and other causes as a result of variable shrinkage. It will be noted that, while the shrinkage in the white casting only varies slightly in low and high silicon, the annealing produces a further shrinkage in the low silicon and an expansion in the high silicon iron. The two lines at the left, Fig. 1, indicate the shrinkage in the white casting, while the other two lines represent the shrinkage of the annealed casting. This phenomenon is of the utmost importance, both to patternmakers and molders and further indicates the necessity of a thorough knowledge of irons in use. Time only permitted the four tests indicated in Fig. 1, as otherwise a few tests would have been made between silicon limits of 0.50 per cent and 0.70 per cent, which would have determined the neutral zone where no further shrinkage or expansion takes place with annealing.

Fig. 3 is a graphic representation of the increase in hardness, measured by the Brinell machine, of steel and malleable iron as annealed and the same material quenched in water from 820 degrees Cent. It will be noted that in the first set all the samples are machinable and while they vary considerably, that variation is much smaller than shown in the quenched state. The steels vary according to the carbon content, but no heat treatment would ren-

der a 0.15 per cent steel unmachinable. The malleable specimens, however, with a few exceptions, are quite unmachinable after this treatment. Since certain brazing and other operations approximate this treatment, it is of value to know which type of malleable is unsuitable for receiving any subsequent heat treatment.

Referring to Fig. 3, it may be stated definitely that any cast malleable of high silicon content, in which a large amount of carbon is left in the graphitic and combined form, is unsuitable. Even a black heart malleable containing no combined carbon is hardened considerably after quenching. The most suitable iron for this purpose is a low silicon, fairly high sulphur metal, in which the annealing is accomplished by the heavy removal of carbon and in which there is a non-hardening ferrite edge, as shown by sample No. 7. Sample No. 5 indicates that even with high silicon, intelligent annealing will produce this non-hardening ferrite edge which is absent in most of the samples tested. The extreme hardness of these samples unfortunately prevented the making of analyses to indicate the exact change in the amount of combined carbon after quenching. Time did not permit of making microscopic examinations.

Fig. 4 is a microphotograph of white pig iron used for malleable iron.

Fig. 5 is a microphotograph of pig iron used for steelmaking.

Fig. 6 is a microphotograph of spiegeleisen used for bringing back the steel baths.

Fig. 7 is an enlargement of photomicrograph *C*, shown at the extreme right, Fig. 15, and is enlarged 1,200 diameters.

Microphotographs of Cast Steel

Fig. 8 contains microphotographs of steel as cast, annealed and oil-quenched. The fact that annealing the steel increased the impact figure from 10 to 30-foot pounds is sufficient proof that annealing considerably improves the quality of the steel. As the question of cost, however, plays a large part in the plans of many steel foundrymen, I do not think that I should suggest that all steel castings should be annealed. The quality of a good steel casting is so good, even as cast, that due consideration must be given to the work to which a casting is subjected in order that the advantages of annealing may not be counterbalanced by the increased cost of manufacture. Where possible, however, a short annealing treatment to release casting stresses is almost necessary. A muffle treatment of from two to six hours duration, according to size and section, at 900 to 960 degrees Cent., and cooling slowly in sand or lime, will meet this requirement. This treatment, however, must not be confused with annealing, as no great alteration to the physical properties must be expected by its use. The main value of annealing, of course, is in the alteration of structure, which produces the change in physical properties.

Referring to Fig. 8, it naturally would be expected that the coarse, angular ferrite and pearlite would be comparatively brittle, while the breaking down of this structure to the more rounded annealed structure indicates a corresponding gain in toughness and ductility. The oil-quenched specimen shows a further breaking down to the fine structure illustrated. It is advisable, however, where oil quenching is resorted to, that such treatment be followed by a tempering treatment. The lead bath is the most effective method of performing this operation and five hours at a temperature of 550 to 570 degrees is a suitable treatment.

Fig. 9 is a photomicrograph, enlarged 1,200 times, of *C*, Fig. 18. This is the photomicrograph shown at the extreme right at the top of this illustration.

Fig. 10 shows very light, mild steel castings as made and also distorted to show their ductility.

Fig. 11 is an enlarged photomicrograph of the photomicrograph *B*, shown in the center of Fig. 21.

Fig. 12 is a photomicrograph of *C*, Fig. 21, enlarged 1,200 diameters.

Fig. 13 is an enlarged photomicrograph of *A*, shown at the extreme right, Fig. 22.

Fig. 14 is a photomicrograph enlarged 1,200 diameters of *C* at the extreme right of Fig. 23.

The following illustrations, Figs. 15 to 25, inclusive, are of a composite nature, illustrating the microscopical, chemical and physical methods of examination. The bars showing the bend tests were 1 inch and ½ inch square in every case. The fractures shown were the fractures of each particular bar at the breaking point. The microphotographs in the foregoing illustrations have been referred to as *A*, *B* and *C*. *A* represents the edge of the structure, *B* the structure between the edge and the center, and *C* the center, except in cases specifically mentioned, where *C* was a high magnification of *B*. In the table of physical properties, *U. S.* indicates the ultimate strength in tons, the yield point is given in tons and the elongation and contraction in area in per cent. *H.* indicates the Brinell hardness factor and *Imp.* represents the impact in foot-pounds as measured by an Avery pendulum machine. The various lots represent samples of malleable iron and steel produced by the leading makers in England. The bars were not ordered as test bars, but the best quality malleable iron was asked for. The tensile tests were made on an Olsen machine of 100,000 pounds capacity and were checked on an Avery machine.

Fig. 15 is a sample of English black heart malleable. Photomicrograph *A* shows the edge, *B* the center as polished and *C* is the center as etched.

Fig. 16 is another sample of black heart malleable, photomicrograph *A* showing the edge, *B* the next edge and *C* the center.

Fig. 17 is a sample of so-called neutral black heart malleable, in which photomicrograph *A* shows the edge, *B* the next edge and *C* the center.

Fig. 18 is a sample of English Reaumur malleable, photomicrograph *A* showing the edge, *B* the next edge and *C* the center.

Fig. 19 is another sample of English Reaumur malleable, in which photomicrograph *A* shows the edge, *B* the center and *C* the center enlarged 1,200 diameters.

Fig. 20 is a sample of high silicon English Reaumur malleable, photomicrograph *A* showing the edge, *B* the center and *C* the center enlarged 1,200 diameters.

Fig. 21 is another sample of English Reaumur malleable, photomicrograph *A* showing the edge, *B* the center and *C* the center enlarged 1,200 diameters.

Fig. 22 is still another sample of English Reaumur malleable, photomicrograph *A* showing the edge, *B* the next edge and *C* the center.

Fig. 23 is another sample of English Reaumur malleable, photomicrograph *A* showing the edge, *B* the center and *C* the center enlarged 1,200 diameters.

Fig. 24 is a sample of mild converter steel. Photomicrographs *A* and *B* show the steel as cast and *C*, the steel as annealed. In the top line are given the physical properties of steel as cast and the bottom line gives the physical results as annealed.

Fig. 25 is a sample of mild electric steel. Photomicrographs *A* and *B* show the steel as cast and *C* as annealed. The top line shows the physical properties of steel as cast and the bottom line the steel as annealed.

Copper production in 1915 passed all previous records and the value of the output at an average price of 17.3 cents a pound is estimated at $236,000,000, compared with $152,968,000 the previous year. The output of refined copper is estimated at 1,647,000,000 pounds, as compared with 1,533,781,000 pounds in 1914, and with the previous record production of 1,615,000,000 in 1913. The average price of copper for 1915 showed a marked increase over the preceding year.

Modeling Clay as an Adjunct to the Foundry

An Artificial Product Which Can Be Used for Making Patterns for Repetition Work and for Changes and Repairs

By C Vickers

IN THIS era of specialization the molder usually is required to attend strictly to his business of molding in order to turn out in a day as many metal duplicates of the pattern given him as may be possible with the means furnished. To this end it is desirable that the pattern be made to leave the sand cleanly, neither tearing off edges nor leaving sharp corners or ridges that will require patching or pressing down in order to insure good castings.

Patterns for repetition work, either for machine or hand service, are, as a general rule, very carefully finished, and leave a perfect impression when withdrawn from the mold. But it is a common occurrence, in the case of patterns of a jobbing character, for the mold to be left in such condition, after their removal, that much patching and "firming" of a highly skillful nature is required on the part of the molder in order to produce satisfactory results.

Transient changes also are often made in patterns for making one or more castings after which they are restored to their former condition. In the case of simple changes, the molder is often required to cut away the molds to enlarge the pattern.

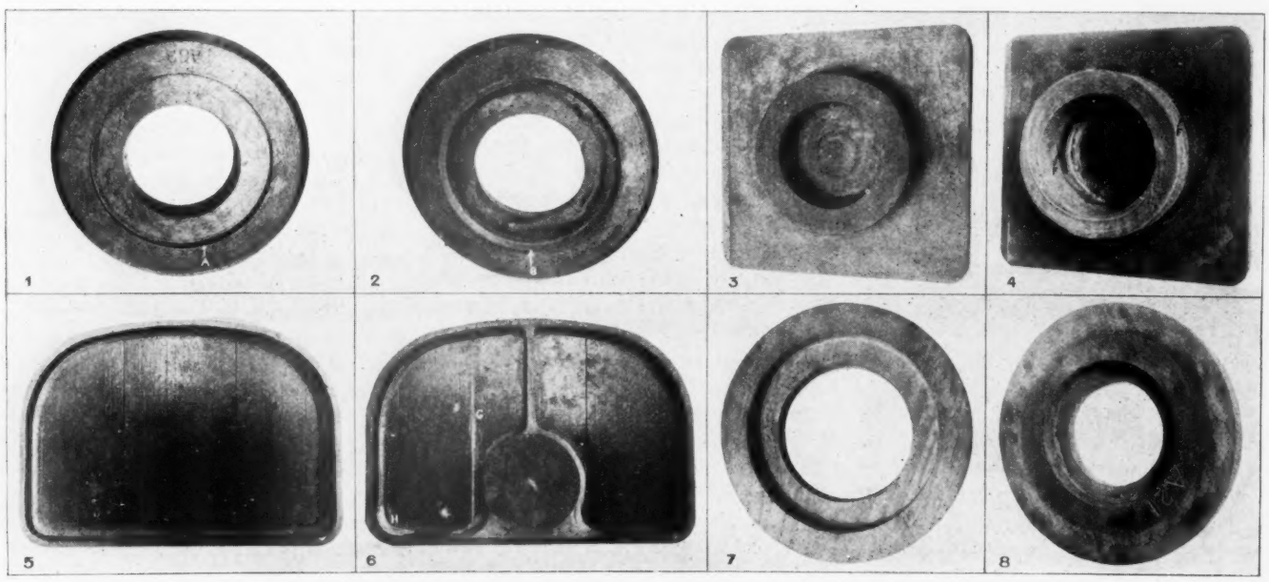
Such a job is illustrated in Figs. 9 and 10, where the stem of the pattern is to be made considerably longer. A molder can accomplish this lengthening by cutting out the sand in cope and drag, but the result is never sightly, and the addition is rarely round, because however skillful the manipulation, molding sand is a difficult thing to carve to any exact shape. Then the time element figures very largely in the case, especially if several castings are to be made having the extension. Where woodworking facilities exist, of course, a cylindrical piece can be easily turned up and attached temporarily to the pattern, but all foundries are not equipped with a pattern shop, and where this important adjunct is lacking, and jack knife methods must perforce prevail, it is exceedingly convenient to be able to produce the shape required by resorting to the art of modeling. Ordinary modeling clay would not be satisfactory for this purpose, because it cannot be used for molding unless it is dried, when it will shrink, crack and lose its shape.

Artificial Clay is Used

A substance that can be used, however, is artificial modeling clay, a material that has been long familiar to the sculptor and modeler. It was developed in response to the demand for a better plastic medium than ordinary clay, which must be kept moist while being worked upon by coverings of wet cloths and waterproof shrouds. Artificial modeling clay, however, never shrinks, cracks, hardens or dries off the surfaces to which it is applied; neither does it grow stale or decompose; it is easily shaped by the fingers, or by tools, and retains its form when so shaped, and it can be used for molding. These qualities render it eminently suitable to the purposes of the foundryman and patternmaker.

Plasticine is the name under which this artificial modeling clay is known, and it is distributed in this country by the Embossing Co., Albany, N. Y. It is composed of perfectly harmless materials, having a decided antiseptic tendency. Neither in a freshly made sample, nor in those that had been freely exposed for over 12 months, or in samples that had been in use in elementary schools for over 15 months could any trace of germ growth be detected by an analyst. Its degree of plasticity does not seem to be materially affected by the state of the atmosphere, and it is sufficiently hard to retain its shape while being rammed up in sand when used as a pattern.

In Figs. 1 and 2, one use of plasti-



FIGS. 1 TO 8—PATTERNS CHANGED OR REPAIRED WITH PLASTICINE

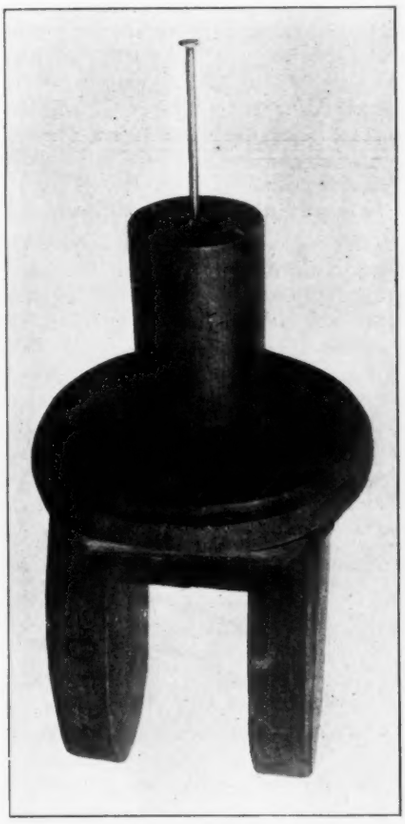


FIG. 9—PATTERN WITH STEM THAT IS TOO SHORT

cine that will commend itself is shown. The center of the pattern constitutes the core print, and the circular inside edge of the pattern at juncture with core print has been left so straight that "bad lifts" were entirely too frequent before plasticine was applied as a fillet, as shown at *B*, Fig. 2. It was applied like putty to a window frame and was afterward smoothed over with a knife, then a little parting was dusted on and rubbed over with the fingers, which is all that is required in order to prevent the sand from sticking to the plasticine. After the first treatment with parting compound, as outlined above, no further precautions are necessary, as there is no danger of the clay sticking any more than the rest of the pattern.

The Clay Sticks to the Pattern

The clay never comes off the pattern, is not indented by the operation of ramming and if pricked with the vent wire, a sweep of the fingers smoothes it off for the next mold. It can be left on the pattern as long as the latter is in the possession of the foundry, and can be quickly stripped off when necessary, leaving no indications of its use.

In Figs. 7 and 8 another application of plasticine is illustrated. Fig. 7 shows the original pattern, and Fig. 8 how it was altered by the use of the clay, about 20 minutes' work being required to make the change. The center of the pattern has been considerably reduced in size and the outer flange made twice as wide as formerly. The recessed portion of the original pattern, Fig. 7, was filled with plasticine and the inner depressed ring was built on. The clay was then

FIG. 10—STEM LENGTHENED WITH PLASTICINE

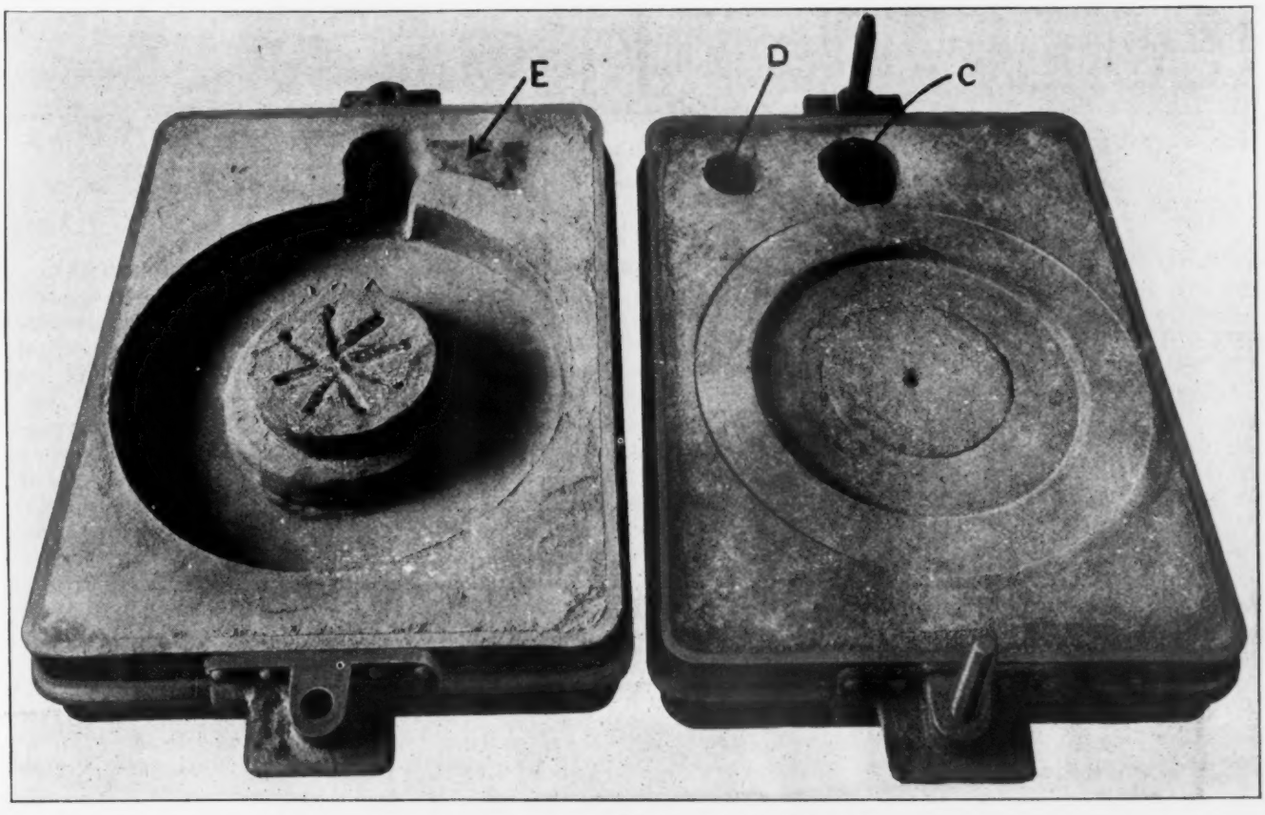


FIG. 11—MOLD MADE FROM ALTERED PATTERN

dusted with parting, the latter smoothed over and the mold was made. The mold as made from the changed pattern is shown in Fig. 11, and it will be noted that the core did not stick, otherwise the vents would have been mutilated, also the pattern number, A 21, is just discernible above the core. The mold was made in green sand, and is shown with gate cut as required for a bronze casting.

The riser, *C*, serves as a feeder, while *D* is the sprue; the channel, *E*, in the drag is cut shallow to enable the sprue to be kept full of metal during the time of pouring. The mold was given a slight inclination toward the sprue, the metal thus running up hill, so that it would creep up slowly and uniformly, instead of racing through the mold, as it would, had the latter been inclined from the sprue. Both riser and sprue were increased in height before casting by the addition of a runner box.

To lengthen the stem of Fig. 9, a nail was first driven in the end, as shown, and the plasticine, rolled to size, was squeezed over the nail and pressed down with the fingers, the result being as shown in Fig. 10.

A pattern with a raised ring is illustrated in Fig. 3, and in this case the height of the ring had to be increased by 3 inches; the result being shown in Fig. 4. The clay was simply built and squeezed on and afterward trimmed to shape, no nails being used to hold it in place. The line of demarcation between the original pattern and the plasticine addition is

(*Continued on page* 80)

Automatic Device for Cleaning Castings

The shaking-out problem has always been a serious one in foundries, particularly in shops turning out a large number of relatively small castings, such as brakeshoes. An automatic device calculated to eliminate the greater part of the manual labor ordinarily expended in breaking up molds and freeing the castings from sand has been patented by Carl A. Peterson, Chicago, and assigned to the American Brake Shoe & Foundry Co., Mahwah, N. J.

As shown in the accompanying illustrations, this device consists essentially of a conical tumbling barrel fitted with lattice bars through which the sand passes while the castings are being rattled. The tumbler is set with its main axis inclined about 30 degrees from the horizontal. The flasks are shaken-out at the upper end and after a suitable interval, the cleaned castings, freed from sand, are discharged from the lower end on to a truck running on a narrow-gage industrial track.

This device is designed for use primarily in continuous foundries where the molds are transferred from the pouring to the shaking-out stations on industrial tracks or other suitable conveyors. As shown in the elevation, Fig. 1, a jib crane fitted with a simple trolley is used for shifting the castings from the mold conveyor to the cleaning device and shaking-out the flasks. The flasks are picked up by a hand-controlled toggle mechanism, which is shown clearly in Fig. 1, and as soon as they are in a suitable position, the sand and castings are knocked out into the tumbling barrel by means of a pneumatically-operated plunger. The plunger cylinder is carried at the lower end of the jib crane trolley.

The tumbling barrel is driven by an electric motor through a sprocket chain, as shown in Fig. 2. The sand drops into an enclosed space underneath the tumbler from which it is removed by a suitable conveyor. This device was designed to supplement the cleaning arrangement described in *The Foundry*, January, 1914; the latter consisted of a series of inclined baffle plates and gratings over which the casting slid from the level of one floor to that of another.

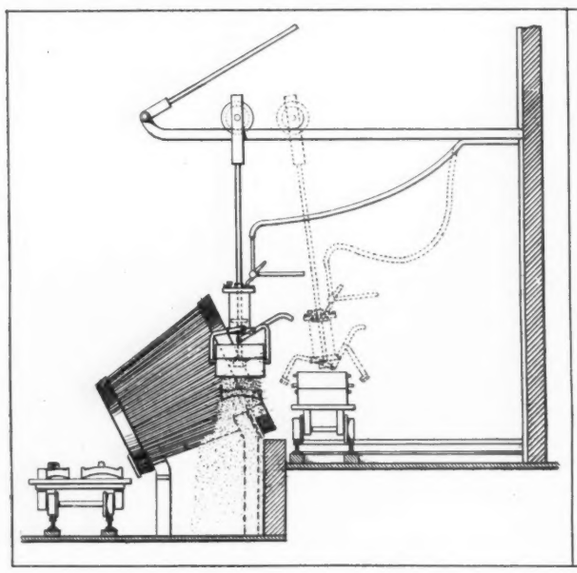


FIG. 1—ELEVATION OF AUTOMATIC BRAKE SHOE CLEANING DEVICE, SHOWING METHOD OF SHAKING-OUT MOLDS AND HANDLING CASTINGS IN TUMBLING BARREL

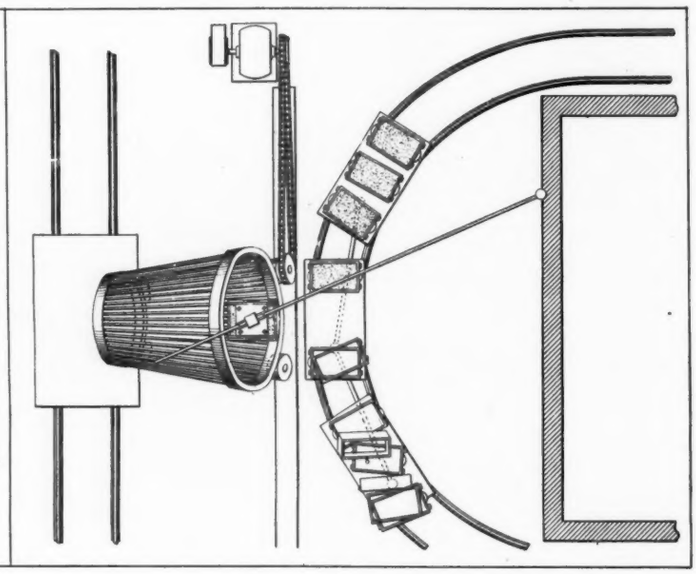


FIG. 2—PLAN OF AUTOMATIC CASTING CLEANING DEVICE SHOWING MOTOR CONNECTIONS AND ARRANGEMENT OF MOLD CONVEYOR

Tungsten Production in 1915

The production of tungsten ores in the United States in 1915 established a new high record and aggregated approximately 2,165 short tons of concentrates carrying 60 per cent of tungsten trioxide and was valued at more than $2,000,000. In the latter part of 1914, 60-per cent tungsten ore was sold at $9 or more a unit and in the early part of last year the price had declined to $5.80 a unit. The demand for high speed steel for munition manufacture increased so rapidly during the summer months and owing to the embargo declared by the British government on the exportation of tungsten ores, the price of this material advanced rapidly until $48 per unit was paid for numerous lots and as high as $50 on small sales was reported.

Judging Non-Ferrous Metal Pouring Temperatures

By Russell R Clarke

WE INVITE particular attention to the first word in our title. It has an important bearing on the nature of the discussion, distinguishing its governing principles from those of others which have appeared elsewhere in the same general connection.

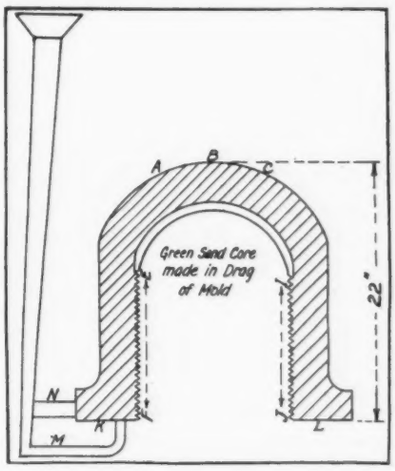
To at once define our position, we will state that our purpose is to accord the efficient pouring temperature of non-ferrous metals a passing consideration, tracing its origin to judgment which is not to be confounded with that of a carefully calculated or experimentally-derived figure.

However, much data arising from experiment with the pyrometer—by virtue of which the most advantageous pouring temperature is determined and recorded for future reference—is of sufficient interest to attract close attention and merit recognition in most any article whose subject is tangent to the general question.

Importance of Correct Pouring Temperature

The importance of the relation between pouring temperature and casting quality can in no wise be questioned. So marked is this relation that molds of perfect construction, poured with the market's best metal, can be made mediums of absolutely worthless castings through error in tempering that metal to a pouring state. Nor does this mean that the metal be chilled to sluggishness or mis-running tendency to produce these results. There is undoubtedly a critical temperature or range of temperature at which best results can be realized and any degree of temperature transgressing this range limit in either direction entails its evil in impaired or worthless castings.

In view of the manifold evils attending the superheating of non-ferrous metals we can accord no foundry practice greater opposition than that with which we denounce excessively hot-metal pouring. It is a mistaken idea that the hotter the metal, the more improved its running tendency. You have, no doubt, often heard the expression, "It's hot enough to run needles." Yes, but will it run needles or is such heat necessary thereto? Have you not noticed in large molds, finely vented in the cope and poured at a medium temperature, with what marked fidelity the metal will run



CROSS-SECTION OF A LARGE SAFETY CAP NUT MADE IN GREEN SAND

the needle-like vent holes? From this we derive the opinion that the running of light castings, or any casting for that matter, is more a matter of molding and pouring method than of getting the metal jumping hot. We might cite as an example a chime whistle body with its intricate cores and thin walls. Time was when we thought no temperature too high for its pouring. We are wiser now, having pickled our experience in the salty brine of too hot as deeply as we ever did in that of too cold metal pouring.

However, the mis-running of castings is the telltale of its own evil and of minor importance when compared to the hidden weakness of apparently solid castings. No non-ferrous foundry can hope to entirely escape this latter evil, though its reduction will accompany close study and observation of pouring temperature under conditions which are favorable to good molding.

To repeat for sake of emphasis, then, the pouring temperature of a non-ferrous metal exercises definite and marked control over casting quality and should be accorded the maximum of consideration in foundry practice.

The Pyrometer Method

What a correct pouring temperature is, its manifestations, governing principles and determining characteristics, from a standpoint of judgment and under varying conditions, are questions on which we aim to shed the dim light of our experience, but in advance of the argument deem it well to accord the pyrometric method our passing notice. As previously intimated, this method consists in experimentally evaluating, by means of the pyrometer, the most efficient pouring temperature of individual alloys and castings or classes thereof, recording this temperature and resorting to this record as a guide to reproduction or calculation in each individual instance of identical or relative conditions recurring.

The value of the method arises chiefly from the continuity of advantage afforded by exact reproduction of a definite and proven temperature, thus eliminating every reasonable possibility of error in tempering a given alloy for a given class of work.

Militating against the pyrometer, however, are serious disadvantages, mainly among which we might mention the unreasonable time required to make a correct reading and the short-lived efficiency of the instrument when continuously subjected to molten copper-basic temperatures. Aluminum foundries can testify to its advantages, but aluminum and brass are different propositions and we have yet to learn of many brass foundries where its advantage is much beyond that of occasional use to either vindicate judgment or correct errors that

might develop and prevail in connection therewith.

Bringing the metal to judgment, then, is the brass man's task and its judgment for him when his judgment fails. Let us see first exactly what is involved in an act of judgment and how it applies to molten metal.

Judgment is an attribute of understanding. No use to tell a molder to pour hot then if he does not understand what in a molten-metal sense, hot is. It is the faculty of comparison, the mind's power of perceiving agreement or disagreement. Evidently there must be a basis of comparison. Evidently some established facts, principles and manifestations of agreement or disagreement. What is it and what are they?

Nature and Application of Judgment

Hot and cold are mere relative terms. Water is boiling hot at 100 degrees Cent., but a furnace at this temperature is considered cold. The same state of metal can be considered too hot for one class of work, too cold for another. How then shall we differentiate hot metal from cold metal in the domain of judgment? The answer is plain, we must compare the extremes of temperature in molten metal. To be more explicit, the mind must be educated to an understanding of metal at its hottest and coldest molten state and the eye trained to discern the differing manifestations in the whole range of difference, after which any temperature can be taken as a base.

But agreement or disagreement implies another process, a fuller understanding. Between a clean, solid, full-run casting a well constructed mold, and a given state of molten metal there may be points of mutual agreement and there may be points of common difference. Likewise, between two metals of varying constituency, yet equal temperature, there may be perfect coincidence with mold and casting demands on the part of the one and perfect rebellion on the part of the other. How, then, shall we also know how to discern this agreement and disagreement. In short, how shall a molder foretell that a certain state of metal will run clean and solid one mold or casting and not another with one kind of metal and not another?

We believe in principles and will state one of our own conception. It is this: *"A developed and enlightened understanding of the nature and modifying particulars of all conditions along with a sense trained to discern closely the manifestations of differing degrees of different molten metal temperatures is absolutely essential to a correct judgment of that metal's efficient pouring state.*

And, mind you, this enlightened understanding idea is basic, deep-rooted and active in demand. So much so that it shapes and enforces the logical order of even its consideration.

Determination by judgment of a correct pouring temperature implies co-operation between the mind and its prompting senses in a dual understanding. Separately considered these understandings embrace—

1.—Distinguishing characteristics of different temperatures in molten metal.

2.—Principles governing conformity of judgment with resulting casting quality.

This latter understanding is a result of long experience and close study of metal temperature relation and variation with individual mold and casting particularity. It combines a knowledge of both metal and mold and demands that the judging agent be familiar with the peculiarities and variations of each alike.

We shall consider each briefly.

A knowledge of distinguishing characteristics is largely a product of the senses of sight and feeling and involves their activity in interpreting degree of metal temperature through its sensible manifestations. Of these manifestations there are many, the more common of which are:

1.—Color or brightness of the molten mass as implied in the foundry expressions *dull color, cherry red, yellow heat, white hot,* etc. The tendency of a rising temperature to approximate sunlight is responsible for these color manifestations. Usually the more intense the brightness, the greater the degree of heat responsible. These manifestations are not always uniform, varying with the degree of surrounding light and differing with its source. In strong sunlight hot metal appears crimson, on a dark day white, in shade on a bright day between white and yellow, under incandescent arc light, a bluish pale.

2.—By the rapidity and intensity of surface oxidation.

3.—By feeling the *jump* of the metal by means of an iron skimmer immersed in the mass and held firmly down on the bottom of the crucible. This test holds good chiefly in high zinc alloys and arises from the high zinc content lowering the boiling point.

4.—Quantitative manifestations of escaping fumes. This also applies chiefly to the high zinc mix where the volatilizing point is comparatively low and accompanied by dense fumes.

5.—By noting the color to which the molten metal heats an iron skimmer after a short period of immersion. Relative degrees of temperature as manifested by solid iron seem more easily detected by the majority of men than through any other medium of exhibition. The fact is no doubt explained by long association with heated iron in common, every-day life and experience and is a good argument against the statement that some men are unable to learn to temper as well as to discern varying degrees of temperature, as manifested by molten, non-ferrous metal.

6.—By using a standard size test bar of kindred material and noting the degree of rapidity with which quantities of this bar dissolve in the molten mass.

7.—By noting the tendency of the metal to cling to the side walls of the crucible or ladle.

8.—By noting the character of the *flow* of the metal on or from the skimmer.

9.—By the fluidity or viscosity of the metal.

Fluidity of the Metal

Fluidity is a consequence of heat, density follows largely its absence. Witness water at zero degree Cent., ice, and 100 degrees Cent. a boiling liquid. Let us talk a moment or more with the melter. He tells us that a pig of metal melts from the outside to the center, much as a snowball dissolves on a warm day; that it first becomes plastic, then granular, then fluid. He tells us also that when pigged it returns to its solid state in reverse order of the above. We know more than that. We know that between granular state and state of maximum fluidity there are as many degrees of fluidity as there are degrees of heat affecting it. Some of the concrete expressions indicating these degrees of fluidity employ such objects as water, milk, syrup, old blackstrap, etc., as mediums of comparison.

As previously stated, we regard the fluidity or viscosity of the metal the logical basis of judgment. Between fluidity or viscosity and temperature there is a definite, approximately invariable relation, uniformly expressed. This means reliability and reliability is paramount in the criterions of judgment. Fidelity to principle gives this method the call, clear and plain over all others of judgment. Resort to its use, however, is often as difficult as desirable. The true inner state of an exposed molten mass is seldom seen, being hidden beneath an oxidized surface covering. Mostly, an insight into actual state must come by a quick *peep* through a charcoal covering hastily removed in spots. The principle is that the eye must be quicker

than oxide development and the judgment accordingly swift in formulating its decision. Development of a fine sense of *touch* or *feel* to detect viscosity, as indicated by resistance to an iron stirring rod in stirring, will also be found a reliable and highly valuable asset in determining temperature. By viscosity we understand that state of metal between its molten, granular and strictly liquid state, in short, its glutinousness. In thoroughly deoxidized metal, where surface indication is a fair criterion of inner state, there can be no good reason for erring in judging a temperature range of even narrow limits.

Final Test of Temperature Agreement

However, in pouring a series of molds with any metal we always observed the practice of giving the first mold poured exceptionally strong protection against sand burning and starting to pour slightly above judgment, making the action of the metal in the sprue head our final test of temperature. Molders should be taught and required to give this feature careful attention. It is their last chance of correction and may save much loss in casting and considerable time and inconvenience in cleaning and chipping.

Should a sprue head chill immediately after pouring and without *drawing* or *feeding*, it may do so at the expense of solidity in the casting and is likely too cold. Should it remain liquid too long and *draw* or *feed* unwarrantedly the logical conclusion is that the metal is too hot and sand-burning, or swelling the casting in consequence.

In view of the wide range which a general article of this nature must cover it is scarcely necessary to state that the foregoing manifestations and conclusions are understood to vary relatively with the nature of the metal and size of the casting. Should metal in the final test be judged too cold for one class of work it may happen that it can be judiciously applied to another in waiting. Such features are those which arise in the rounds of daily experience and should be made opportunities of study and profit. From this we pass to the principles governing conformity of judgment with resulting casting quality. Varying the phraseology, we have now to consider the question: "What, as indicated by judgment, is a correct pouring temperature?" Is it white heat, cherry red, syrup-like viscosity, granular state or what? We answer tersely, it is a variable, not a constant. In short, a pouring temperature varies with

1.—The nature of the metal.
2.—The nature of the mold.
3.—The nature of the casting.
4.—The nature of the opposition.
5.—Time consumption in pouring execution.

Two, 3 and 4 may appear identical though we discern lines of demarcation sufficiently strong to warrant considering them separately.

First we will consider the nature of molten metal in general. Nearly all metals in the process of reduction from their solid to their state of maximum fluidity, or we might say their volatilizing state, pass five important points which superinduce either physical or chemical change, or both. These points might be considered under the general head, *changing points* and named in order, are: Freezing point, fusing point, boiling point, kindling or rapid oxidation point and volatilizing point. Briefly defined and in order, these points are:

1.—That at which liquid metal solidifies.
2.—That at which solid metal passes to liquid state.
3.—That at which a liquid metal has absorbed all the heat of which it is capable and manifests evidences of throwing it off.
4—That at which a metal *burns* or supports combustion.
5.—That at which a metal assumes a gaseous state.

The order observed can be generally accepted, though there are instances of its violation.

The boiling, kindling and volatilizing points approximate identity or at least possess many features in common.

Correct Pouring Temperature

From a consideration of our definition of boiling point and a moment's reflection on boiling water, we can derive useful information on the question under discussion. Water heats to 100 degrees Cent. or 212 degrees Fahr., boils and gets no hotter under ordinary conditions regardless of the degree of heat applied. That the liquid state of a solid metal obeys the letter of the same law may be an unwarranted assumption, although it is perfectly reasonable to consider it substantially influenced thereby. Moreover, since boiling temperature approximates volatilizing temperature and volatilizing temperature is an extremely oxidizing temperature, then in a pouring sense metal at boiling temperature is no more fluid than at a reasonably lower temperature, this arising from the fact that metal at boiling temperature is mechanically densified by oxides rapidly formed and entrapped in the process of pouring. That is, the extreme heat of the metal renders it highly susceptible to rapid oxidation even in dropping to and running the mold, while the commotion superinduced by the dropping churns the oxides thus developed to incorporation in the mass, detracting from its fluidity and impairing its quality in general. It is, therefore, obvious that there can be few good reasons for heating to or pouring at a jumping temperature while there is an abundance of common-sense logic against it.

Evils of Pouring Extremely Cold

So much for the one extreme, now for the other. Three features lie open to consideration. They are transmission of pressure, entrapping density and congealing resistance. In mold pouring, molten metal is obedient to natural principles among which are those by virtue of which liquids rise to their level and transmit undiminished and in all directions any or all additional pressure. This rising and transmitting tendency varies with the degree or liquidity, diminishing with approach to density to its total absence in solidity. There is also a state of reduced fluidity that will permit sufficient transmission of pressure to run and overcome shrinkage in the casting, yet prevent the escape of foreign matter, such as scale, oxide, etc., to the surface of the metal in the pot. Metal at such a temperature may be said to be in a state of entrapping density. In addition, a consideration must be accorded the fact that approach to freezing point is much more rapid in the mold than in the air or crucible, having the dampness of the sand and a reduced mass in its favor. This tendency of the metal to freeze more rapidly in the mold than in its source of supply, thus operating against a running tendency or driving pressure, is the applied sense of congealing resistance.

To summarize then in general terms, non-ferrous metal should be poured at that temperature or range of temperature productive of a fluidity permitting amply free transmission of pressure, overcoming too rapid freezing in the mold and giving free and untrammeled escape of all foreign matter to a surface position—so hot and no hotter.

Such is our general conception of metal pouring temperature and such its general expression. Native to the subject, however, is a wide range of particularity not investigated in a general survey and of too much importance to escape notice. Quantitatively considered, copper is basic to the majority of non-ferrous alloys. Of its most common alloyed associates, it is also highest in most *changing points*. In the main, these associates are tin, lead, zinc and aluminum, others such as nickel, manganese, etc.,

are sometimes used, though they constitute the minority of cases and in quantities too small to warrant consideration here. To subserve our present purpose we shall classify nonferrous metals under seven different heads as follows:

1.—Pure copper and silicon; 2, high tin; 3, high lead; 4, high zinc; 5, pure aluminum; 6, aluminum and copper; 7, a medium covering 2, 3 and 4.

Seeking escape from confusion or misapplication of our remarks, we select a sample in each individual instance, submitting in order formulas covering and assuming each metal to contain 50 per cent virgin material of good quality:

2.—Copper, 83 1/3; tin, 16 2/3.
3.—Copper, 76 or 76½; tin, 4; lead, 20; nickel 1, or ferro-manganese, ½.
4.—Copper, 66 2/3; zinc, 33 1/3.
6.—Copper, 90; aluminum, 10.
7.—Copper, 80; tin, 5; lead, 5; zinc, 10.

To this we add a phosphorus-deoxidized alloy as copper, 79; tin, 10; lead, 10; phosphorus, 1.

In the interest of still further definiteness our remarks will be understood to apply to a casting weighing about 70 pounds and approximating a surface area of 230 square inches.

1—*Pure Copper and Silicon*

In a mixture of pure copper and silicon, the object of the silicon is to deoxidize and overcome casting tendency made difficult by absorption and liberation of gases by copper. Copper should be melted to skimmed milk consistency, slightly above yellow temperature, and silicon added till all unrest disappears. The action of the metal in the sprue is the final test for silicon. If the metal fails to *feed* or *draw* properly, add more silicon. The sprue head indication of feeding should be strong.

2—*High Tin—Copper,* 83 1/3 *Tin,* 16 2/3

A perfect alloy, strict chemical union, complete blending of derived qualities, everything changed, freezing point, fusing point and boiling point. Casting and *running* tendency the best. Liquidity prolonged beyond indications and expectations. Sterling castings by metal almost guaranteed. No need to pour hot, better pour rather cold. Sluggish appearance of mass need cause no alarm. Smooth, solid appearing surface resembling molten iron. Between dull yellow and red, with rainbow color in evidence under gentle surface commotion. Tin features manifest, viscosity strong, pour hard and rest easy. Sprue head indication of feeding slight.

3—*High Lead.—Copper,* 76 *or* 76½; *Tin,* 4; *Lead,* 20; *Nickel,* 1, *or Ferro-Manganese,* ½ *of* 1.

Many conflicting conditions operating against casting quality. Lead hard to control, frequent stirring reduces temperature; phosphorus deoxidizer not tolerated by lead; oxidation rapid; high fluidity forbidden by tendency of lead to go down, by inability of oxide to come up; low shrinking tendency marked; sour cream-like, sluggish appearance of surface no indication of inner state; tendency of metal to drag and flow in sheets in pouring. Fluidity largely mechanical and not uniform. Liberation of gases by nickel to be contended with. Correct temperature hard to judge, on the warm side no doubt safest. Best indications: Color, bright yellow; inner state of metal, thin syrup-like; oxidizing appearance, rapid; viscosity, not reliable. Pour hard and encourage rapid reduction of temperature in casting. Sprue head indication of feeding, marked.

4—*High Zinc.—Copper,* 66 2/3; *Zinc,* 33 1/3.

Common, or yellow brass; boiling point, low; tendency to cut, strong; dry sand molds safest. Temperature indicated by *jumping* or *cracking* in iron skimmer immersed, by presence of zinc fumes, color and viscosity. Fluidity of thin syrup, consistency fumes subsiding show dull red color, jumping scarcely susceptible are evidences of pouring state. Sprue head indications of feeding advanced.

5—*Pure Aluminum.*

A white metal of low specific gravity. Metal in mold easily disturbed and displaced by gases generated. Freezing point, low; fluidity, strong and suspended; shrinking tendency, marked. Hot metal remains liquid in mold until subjected to impairing tendency of late gas development. Best results obtained by pouring rather cold. Indications of safe temperature: Viscosity, strong; mass inclined to sluggishness; evidences of approaching granulation, noticeable; metal of *rolling* tendency resembling quicksilver; color of dull lead-polished appearance shaded with subdued dark red. Sprue head indications of feeding, slight. Metal rising in *risers* should show marked granulation and sluggishness.

6—*Aluminum and Copper—Copper,* 90; *Aluminum,* 10.

A hard proposition; wide margin between specific gravity of constituents. Affinitive tendency *touchy* and easily impaired. Metal flows and runs in wave-like rolls. At rest in liquid state too long, aluminum and copper tend to disunite in molecule. Poured too cold, waves of metal fail to unite properly, causing seams in casting; too hot, blending quality weakens during extended period of solidification. Critical point lies between these degrees of temperature. Indications: Color, between subdued yellow and dark red; viscosity, strong; metal on surface disturbed or displaced flows lazily together forming compact mass. In mold construction metal chilling tendency should be given every warranted consideration, the object being to get the metal into the mold at its lowest efficiently combining temperature and encourage rapid solidification thereafter.

7—*Medium of* 2, 3 *and* 4.—*Copper,* 80; *Tin,* 5; *Lead,* 5; *Zinc,* 10.

Red brass; quality, good; surface oxidation, rapid; inner state, hard to discern; cold metal has strong tendency to produce dirty castings; high degree pouring temperature, safest. Indications: Color, yellow tinged with blue; slightly perceptible fumes, viscosity of inner mass of serum consistency; fluidity noticeable through oxidized surface of pouring stream; sprue head indications of feeding, advanced. Requires ample pressure.

8—*Phosphorus—Deoxidized Alloy—Copper,* 79; *Tin,* 10; *Lead,* 10; *Phosphorus,* 1.

A strong, hard bronze of excellent quality. Combined high tin and lead favors prolonged fluidity. Deoxidizing influence of phosphorus gives metal freedom from mechanical density. Surface appearance almost identical with inner state. Presence of phosphorus superinduces sand-burning perceptibly. Pour rather cold, observing indications: Blood-red color; slight intimation of granulation; buttermilk suggestiveness in flowing on or from skimmer; viscosity of thick syrup-like consistency; slight evidence of coagulation on walls of crucible and immersed skimmer. Stir frequently to preserve uniformity of temperature in mass and pour hard. Sprue head indications of feeding, average.

There is another variation which arises from the quality of the metals used. Different brands of material and their worth are known to most wide-awake foundrymen, while an all-scrap product soon becomes an open secret to most any molder. In the majority of cases, excellent results can be obtained by pouring a sterling brand of metal far below the temperature at which a less reliable product

will yield satisfactory results. The same applies between metal of fair quantitative virgin composition and an all-scrap mix. Most any foundryman knows that metal once melted is never again the same and metal melted over and over again slides rapidly down the scale of quality. Inferior brands and scrap material must be poured at a higher temperature than good metal and the sad consequence is that we are compelled thus to take still further from the all too little quality of which that inferior brand is possessed.

Considering the nature of the mold, we differentiate degrees of temperature as applied to molds with and without core complement, to molds of varying ratios between solid content and surface area figures and dry and green sand molds. Molds for heavy, chunky castings containing small cores cannot be poured as hot as similar molds without them nor need a mold for a small pin, 12 inches in diameter by 22 inches long, be poured as hot as one for a disc 40 inches in diameter and 2 inches thick, though the amount of metal required is approximately the same in each instance. Again, a mold for a solid hub can be poured much colder than a mold containing the same hub with fan blades attached, core complements and all in the latter case to the contrary notwithstanding. As for dry and green sand molds, congealing tendency is less in the former than in the latter and admits a choice of lower temperature if otherwise justified.

Nature of the Casting

The nature of the casting embraces chiefly the degrees of particularity in different castings. For illustrative purpose we shall compare a crown brass with a car bearing. The former is a bearing applied direct to a journal; the latter the back of a babbitted or lined bearing. Particularity is high in the crown brass, consequently the mold must be prepared to receive metal at a naked-sand-burning temperature. To accord the car bearing mold the same precaution would entail too great a molding expense, while to pour at the same relative temperature would merely transfer this expense to the chipping and cleaning department. Particularity in the bearing will not justify either, so pouring the metal slightly below its most efficient temperature is the natural means of escape.

In filling a mold with metal our notion is that a general practice of pouring hard rather than easy is a logical one. Yet instances come up where hard-pouring finds settled opposition in mold construction. It is quite evident that the slower a mold is poured the hotter the metal must be in pouring it. Consequently, mold construction is often responsible for opposition to the demands of which metal temperature must comply. A simple instance will demonstrate our point.

Pouring Safety Cap Nut

The accompanying illustration is a cross-section of a large safety cap nut made entirely in green sand. The opposition lies in the tendency of the swift inrushing metal to dig or tear away the soft core in pouring hard at medium temperature and in its liability to congeal or run cold and dirty over the top surface, *A, B* and *C,* in pouring slow at the same temperature sufficiently high to insure harmony between slow pouring and casting solidity. In this illustration, *EF* and *IJ* are the surfaces to be threaded; *K* and *L* are the joint surface and *M* and *N* show the gates and suggest the probable action of the metal against the green sand core in pouring extremely hard. Also note the height to which the metal has to rise in the mold. Other practical instances will be found in molds containing cores of large body and small prints permitting only inadequate channels for the escape of gases. In this the metal must be poured sufficiently slow and hot to allow the core to discharge its excess gas in advance of a filled mold or solidified metal regardless of other considerations. In this connection we are acquainted with a class of work where a momentary pause in pouring is essential to satisfactory results.

In this, reference is made to the time required for mold distribution of metal. With 800 pounds of metal to be disposed of there is an elapse of considerable time between the pouring of the first and last of a series of molds aggregating 10 or more in number.

In this *interim,* reduction of temperature is superinduced by radiation, stirring and reduction in mass. It therefore is a common sense conclusion that the first mold must be poured at a higher temperature than the last.

That a judgment developed by long experience and elaborated by close application will be sometimes found wanting is only in keeping with the erring tendency of human nature in general. Liability to err, however, is often more directly the result of carelessness in tempering manipulation than a consequence of misconception. In guarding against this carelessness two particulars are especially prominent. They are tempering without stirring and tempering too close to desired temperature too long in advance of pouring execution. Solid metal usually floats in a liquid mass of kindred material, though at introduction it often sinks to the bottom of the crucible and sticks there. All added metal in tempering should be stirred to dissolution to insure uniformity of state. Otherwise the lower content of a molten mass may chill to sluggishness while the surface remains quite hot and misleading. Moreover, metal in close proximity to a critically-reduced pouring temperature dissolves added metal very slowly. At this stage the practice of adding solid metal in small amounts and waiting for complete dissolution to manifest the definite effect indicates a better and safer policy than introducing a larger amount whose quantitative feature is derived from a conceived or calculated effect. Likewise, in pouring large castings demanding critical temperature, judgment is unnecessarily overburdened by bringing the metal to a final proximity before starting from the furnace vicinity and calculating on the exact reduction in temperature which radiation will further accomplish.

Pouring Temperatures

Out of these considerations arises our opinion that large castings of critical temperature-requisition in pouring should be poured by a man relieved of temperature responsibility and the metal tempered by a man in attendance and competent to judge. The final tempering should be done with the pot in position to start pouring at the immediate direction of the man tempering.

From a great mass of conflicting testimony, above the fusing point of the average alloy for the average casting, we discern the average figure 150 degrees Cent. Further, and more definitely applied values, give yellow brass (copper, 66 2/3; zinc, 33 1/3) 1,050 degrees Cent., and gun metal (copper, 88; tin, 10; zinc, 2) 1,100 degrees Cent. as a correct pouring degree. These alloys in order melt at approximately 915 and 1,000 degrees Cent., the one slightly below and the other considerably above the boiling point of zinc (920 degrees Cent.). An efficient pouring temperature for aluminum bronze is 80 degrees Cent. above its fusing point as given and for red brass 1,120 degrees Cent.

Though entirely unfamiliar with the physical manifestations by which these temperatures are accompanied, we are, nevertheless, seriously inclined to question the wisdom of their general application in positions where specific cases are much in evidence.

PROBLEMS OF THE BRASS FOUNDER

What To Do and How To Do It

Spongy Bronze Castings

The bronze castings which we are making and which weigh approximately 100 *pounds are spongy. The mixture consists of copper,* 85 *per cent; lead,* 2½ *per cent; zinc,* 2½ *per cent; tin,* 5 *per cent and phosphor tin,* 5 *per cent. We use natural draft furnaces but do not employ a pyrometer for ascertaining the temperature and we would like to know whether it would be advantageous to use a pyrometer in our work.*

Only a comparatively few foundries use pyrometers to ascertain the temperature of the metal at the time of pouring and therefore your difficulty cannot be assigned to the lack of an instrument. We suggest that the mixture be modified by omitting the zinc entirely and increasing the copper content 2.5 per cent. If this does not give the Brinell hardness required, increase the tin 0.5 per cent and copper 2 per cent. It also would be advisable to pay particular attention to the melting, using plenty of charcoal to cover the surface of the metal and a small amount of salt should be added when the metal is first charged. If these precautions prove unavailing, use hard coal around the pots in place of coke.

Preventing the Washing of Sand in Molds

We are experiencing considerable difficulty in making a small yellow brass casting which has a ridge ½ inch high and only about ¼ inch thick. The metal, as the mold now is gated, must flow over this ridge, but it washes it away if the ridge is not secured with nails. It is our effort to make this job as cheaply as possible and we would like to know how to overcome this difficulty without the use of cores or pegs. The mold is made from Albany molding sand and is sprayed with a strong solution of molasses water.

The most satisfactory way of making these castings would be to place a print on the patterns and to core out the ridge. If the sand is pegged and saturated with molasses water, skin-drying is necessary and it would be more economical to make a facing consisting of 75 per cent of molding sand and 25 per cent of sharp sand wet with a solution of equal parts of water glass and water. It will be necessary to use kerosene on the pattern, but if in spite of this the sand sticks, mix it with water and when the patterns are drawn saturate the ridge with the water glass solution, after which the mold should be skin-dried. The water glass will cause the ridge to become as hard as a core and it will not wash nor will it blow, as no gas is given off. However, the treated sand will adhere to the casting more than ordinary sand and if this difficulty persists, it can be remedied by dusting the ridge before drying with a small amount of plumbago.

An Alloy That Will Not Tarnish

Can you recommend an alloy that will stay bright in salt water? We could use lead, but this would have to be scraped periodically; but what we want is an alloy that will retain its luster regardless of salt water service.

We know of no alloy that will retain its luster in salt water. Manganese bronze is used largely for casting propellers for sea-going vessels and might be satisfactory in this instance.

The following alloy can be used: Copper, 58.5 per cent; zinc, 38 per cent; tin-plate, 0.5 per cent; ferro-manganese, 2 per cent; tin, 0.5 per cent, and aluminum, 0.5 per cent.

If a soft metal, similar to lead, would be more satisfactory, it probably could be used if the polished surface were protected by a coating of lacquer.

Aluminum Shot

We would like to know how aluminum shot is made.

Aluminum shot is made in different forms, the spatter being produced by pouring the molten aluminum into water from a suitable height. Finely granulated aluminum is made by spraying molten aluminum in a box containing baffles. The spray is produced by a jet of carbon monoxide or nitrogen gas. This method, we understand, is patented. The aluminum also can be granulated by stirring it vigorously while the metal is at the chilling point. This method, however, has the disadvantage of allowing the grains of aluminum to become coated with a film of oxide which retards the reaction when the aluminum is used to produce the thermit reaction with such refractory oxides as iron or titanium.

Aluminum Mixtures

What are the analyses of the different aluminum mixtures commonly employed and also we would like to know their physical properties?

The alloys most commonly employed follow:

Aluminum, 92 per cent, and copper, 8 per cent.

Aluminum, 82 per cent; copper, 3 per cent, and zinc, 15 per cent.

The physical properties of the first alloy follow: Tensile strength, 18,000 to 20,000 pounds per square inch; elongation in 2 inches, 1 to 2 per cent; specific gravity at 20 degrees Cent., 2.8; Brinell hardness under 500 kilograms pressure for 30 seconds, 50 to 55, and weight per cubic inch, 0.10 pound.

The physical properties of the second alloy follow: Tensile strength, 20,000 to 26,000 pounds per square inch; elongation in 2 inches, 1 to 3 per cent; specific gravity at 20 degrees Cent., 3.1; Brinell hardness under 500 kilograms pressure for 30 seconds, 60 to 65, and weight per cubic inch, 0.11 pounds.

Making Statuary Bronze

I would like to produce small statuary castings which must be made by the lost wax process. Thus far, however, I have been unable to obtain a satisfactory bronze mixture. Around the wax figure I have cast a composition consisting of one part of plaster of Paris and two parts of fine brass foundry sand. This is the nearest approach to brick dust that I am able to obtain. It has been stated that the composition should contain one part plaster and two parts brick dust. The molds have been baked as long as 36 *hours, yet notwithstanding this fact, the castings were full of blow-holes. Can you furnish me the formula for the mold composition and suggest the precautions necessary for producing satisfactorily bronze statuary work? Also, I would like to have a good mixture for such bronze.*

Sand and plaster of Paris will not make a satisfactory mold for the casting of statuary. The object in using brick dust is to control the shrinkage of the plaster as much as possible and to prevent the cracking of the mold. Ordinary red brick should be employed for this purpose

and not fire brick, and they may be pulverized in a mortar and the large pieces screened out. A number of refractory substances other than brick dust can be employed in connection with plaster to form a molding medium for under-cut work. What is required is a refractory, porous mold that can be baked and gradually raised to a full red heat without excessive cracking or loss of strength. At the same time this substance must form a sufficiently porous mold to permit the escape of gases generated while pouring. Brick dust, however, is satisfactory especially if mixed with a small amount of comminuted asbestos. The molds should be dried slowly and then baked to expel all moisture, after which they should be raised to a red heat.

The following alloy will give good results: Copper, 90 per cent; tin, 5 per cent; zinc, 4.5 per cent, and lead, 0.5 per cent.

Government Bronze Mixtures

We would like to have the government specifications for cast and Tobin bronze.

The government specifications for bronze are as follows:

Gun bronze: Copper, 87 to 89 per cent; tin, 9 to 11 per cent; iron, 0.06 per cent maximum and lead, 0.30 per cent maximum.

Journal bronze: Copper, 82 to 84 per cent; tin, 12.50 to 14.50 per cent; zinc, 2.50 to 4.50 per cent; iron, 0.06 per cent maximum and lead, 1 per cent maximum.

Valve bronze: Copper, 87 per cent; tin, 7 per cent; zinc, 6 per cent; iron, 0.06 per cent maximum and lead, 1 per cent maximum.

Tobin bronze: Copper, 59 to 63 per cent; zinc, 35.50 to 40.50 per cent; tin, 0.50 to 1.50 per cent; iron, 0.06 per cent maximum and lead, 0.60 per cent maximum.

A Mixture for Gears

We are making a small gear, about 3 inches in diameter, from government bronze, but we find that it is too hard for this purpose and the gear is exceedingly noisy when in operation. We would like to have a mixture satisfactory for this purpose which will have little or no metallic sound.

A softer metal could be produced by reducing the amount of tin in the mixture, but it is doubtful whether this procedure would lessen the noise to any great extent. However, we would suggest that you give the following mixture a trial:

Copper, 89 per cent; tin, 6 per cent; zinc, 3 per cent, and lead, 2 per cent.

Babbitt Metal and Manganese Bronze Mixtures

We would like to have babbitt metal mixtures for high speed, low speed and medium speed work. Also give several manganese bronze mixtures in pounds, including physical properties, such as tensile strength, elongation, reduction in area, etc.

The following alloys should prove satisfactory:

Babbitt for high speed: Tin, 89 per cent; antimony, 8 per cent and copper, 3 per cent.

Medium speed: Tin, 60.75 per cent; antimony, 10.50 per cent; lead, 25 per cent and copper, 3.75 per cent.

Low speed: Lead, 80 per cent; antimony, 15 per cent and tin, 5 per cent.

Manganese bronze having an ultimate strength of 80,000 pounds per square inch and over, an elastic limit of 40,000 pounds per square inch and over, an elongation of 21 per cent on 2 inches and a reduction of area of 22.1 per cent, can be made as follows:

Copper, 56 pounds; zinc, 42 pounds; iron, 1.5 pounds; tin, 1 pound; aluminum, 0.5 pound and ferro-manganese, 0.5 pound.

Another manganese bronze mixture follows: Copper, 62 pounds; 30 per cent manganese-copper, 6 per cent; zinc, 40 per cent; tin, 1 pound; iron, 1 pound and alumium, ½ pound.

The physical properties of this alloy follow: Ultimate strength, 60,000 pounds per square inch; elastic limit, 27,000 pounds per square inch; elongation on 2 inches, 30 per cent and reduction of area, 27 per cent.

A 50-50 Copper Lead Mixture

In the December number of The Foundry, page 501, is given a mixture for metallic packing for locomotives consisting of 60 per cent copper and 40 per cent lead. The statement is made that sulphur generally is used to hold the lead in combination and this may be added in the form of roll sulphur or by means of plaster of Paris. We would like to know whether the sulphur should be used in the powdered or stick form, and what quantities should be employed? Also, we would like to have some advice regarding the use of plaster of Paris in this mixture. We have an order for a number of castings to be made from an alloy consisting of lead, 50 per cent and copper, 50 per cent and we would like to know how to make this mixture so that it will be homogeneous.

It is immaterial in what form the sulphur is added, but the stick form is more convenient than the powder. Plaster of Paris sometimes is used in place of sulphur as sulphur is imparted from it to the metal, assisting in retaining the lead in solid solution with the copper. Considerable difficulty may be expected in obtaining a homogeneous mixture of lead and copper in the proportions mentioned and we suggest a few experiments before beginning on the order to determine the exact quantity of sulphur or plaster of Paris that should be added to hold the lead in combination with the copper. The use of too much sulphur will cause the surface of the castings to become filled with shallow holes similar to those frequently found on brass ingots cast in iron molds. The fluid metal should be free from any odor of sulphur dioxide when it is removed from the furnace.

Instructions for School Work

In our school work we are casting brass escutcheons, door plates, placques, etc., and we receive from the school board only brass scrap, such as plumbers' supplies, electric and gas fixtures. We would like to know how to obtain the best results with this material and whether or not new metal should be added. We would like a good mixture for a 50-pound charge. Also kindly advise us whether the following method of melting these metals is correct: Copper, zinc, lead and tin.

The scrap should be sorted before it is used, as red and yellow brass scrap should not be mixed indiscriminately. The sorting process is not difficult if each object is filed slightly to show the color of the metal underneath the skin. If the cut is yellow, the object is yellow brass, and if red, it is red brass. Red brass can be cast more easily than yellow brass. It does not smoke so much as the latter, and fills out the mold more satisfactorily. Yellow brass used for plumbers' supplies will approximate the following composition:

Copper, 68 per cent; zinc, 27 per cent, and lead, 5 per cent.

Red brass used for builders' hardware will have approximately the following composition if made of high-grade material:

Copper, 87 per cent; tin, 7 per cent; zinc, 3 per cent, and lead, 2.50 per cent.

Red brass faucets consist approximately of the following:

Copper, 87.55 per cent; lead, 4 per cent; tin, 3.60 per cent, and zinc, 4.85 per cent.

In making the mixtures all sorted scrap can be used, or 50 per cent sorted scrap and 50 per cent new metals mixed according to any of the foregoing formulas will be satisfactory. The yellow brass scrap should be reserved for the yellow brass heats.

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Contents

A Converter Steel Foundry for Diversified Work 43
Variations in Malleable Shrinkage 48
How Castings for Automobiles are Inspected 49
Machine-Molding a Grinding Mill Frame 51
New England Foundrymen Elect Officers 52
Smelting Company Organized 52
Problems in Pipe Foundry Practice Discussed 53
Number of Tuyeres in a Cupola 56
Acid-Resisting Metal 56
Mounting Patterns for Molding Machine Work 57
The White Core Returns 59
A One-Piece Printing Press Frame 60
Science Testing of Malleable and Cast Steel 61
Modeling Clay as an Adjunct to the Foundry 68
Automatic Device for Cleaning Castings 70
Tungsten Production in 1915 70
Judging Non-Ferrous Metal Pouring Temperatures 71
Spongy Bronze Castings 76
Preventing the Washing of Sand in Molds 76
An Alloy That Will Not Tarnish 76
Aluminum Shot 76
Aluminum Mixtures 76
Making Statuary Bronze 76
Government Bronze Mixtures 77
A Mixture for Gears 77
Babbitt Metal and Manganese Bronze Mixtures 77
A 50-50 Copper Lead Mixture 77
Instructions for School Work 77
Trade Outlook 78
Death of Horace G. Boughton 79
New Electric Steel Company 79
Death of George H. Cushing 79
Book Review 79
The Mumford Pattern-Drawing Machine 80
Personal 80
New Power Squeezer 81
Profit-Sharing With Sales Force 81
Melting Manganese Copper 81
General Industrial Notes 82
New Trade Publications 82

Trade Outlook

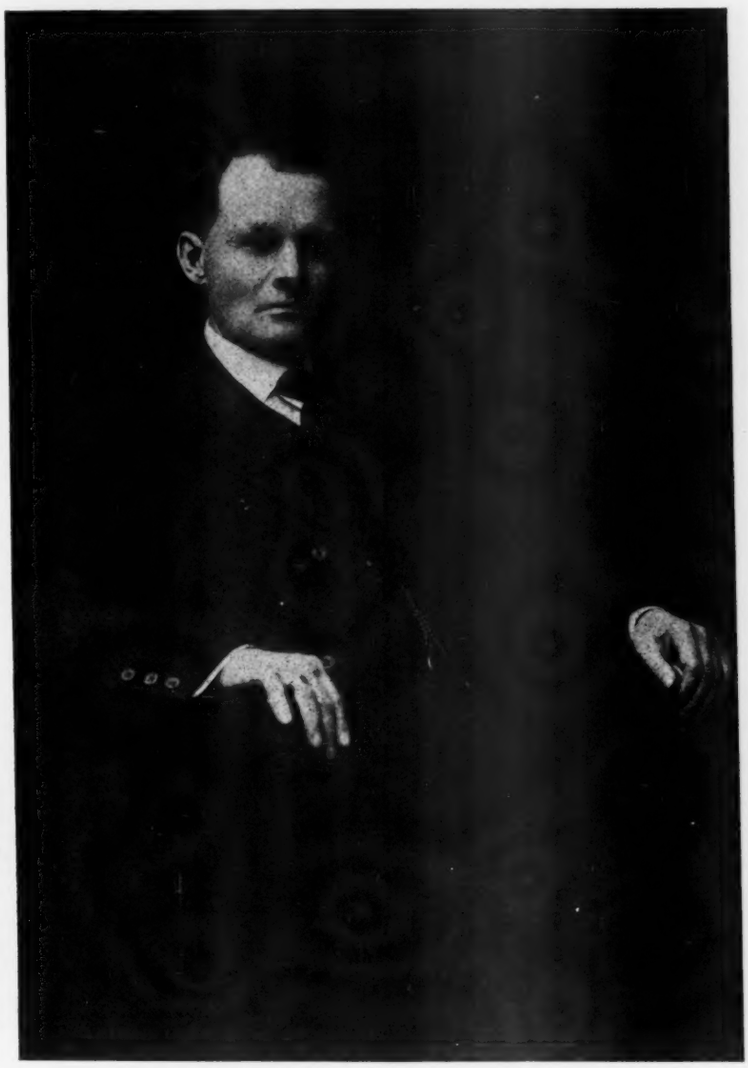
NEW tonnage no longer being a problem of difficult solution, casting manufacture has resolved itself into a question of deliveries. Every branch of the foundry industry east of the Mississippi river is enjoying unparalleled prosperity and from present indications demand will not slacken its present pace throughout the first half of the year at least. The melt during the month of January set a new high record and with the pressure on all shops for deliveries, the daily output in February will be further increased. Makers of machinery castings in New England and the Cincinnati districts are unable to meet the needs of tool builders dependent on them, notwithstanding almost general enlarged capacity. Malleable and steel founders, who to a large extent have obtained their tonnage from the railroads, are finding other outlets sufficient to warrant the maximum operation of their plants. Roll makers and foundries supplying castings to builders of rolling mill machinery, due to the activity of the steel industry, are months behind on their deliveries, with new tonnage coming to them greatly in excess of their shipments. Jobbing foundries in iron and steel producing centers, in many instances are operating overtime to meet the insistent demand for castings for repairs. Foundries specializing in automobile work are having difficulties in complying with the almost hysterical calls for material from the motor car builders, all of whom are contemplating greatly increased production this year. Higher quotations are not deterring municipalities from closing for their cast iron pipe requirements and the pipe shops are unusually active, the season considered. Surprising reports also are heard from the stove trade. The open winter has had no appreciable affect on purchases, and while fill-in orders for heaters no longer are received, the demand for cook stoves is almost unprecedented. The stove shops, therefore, continue to operate close to capacity on goods for immediate shipment. No period of prosperity in the foundry industry, however, is unaccompanied by labor difficulties, and the 8-hour day is the demand that is now confronting foundrymen in many centers. In the Pittsburgh district most of the shops are resisting the new schedule, although many casting manufacturers, in various parts of the country, already have yielded. In view of the heavy pig iron output, melters are having little or no difficulty in obtaining raw material, although the fuel problem is becoming alarming, not only as regards price, but also supply. Pig iron prices softened slightly early last month, but quotations are practically unchanged, as compared with December and, in the leading centers, are as follows: No. 2, Pittsburgh, $19.95; Cleveland, $19.30; Chicago, local, $18.50; Philadelphia, $19.25 to $19.75; Buffalo, $18 to $19, and Birmingham, $14.50 to $15. Malleable is held at $19.95, Pittsburgh; $20.50, Philadelphia, and $18 to $19, Buffalo.

Death of Horace G. Boughton

Horace G. Boughton, president of the Standard Sand & Machine Co., Cleveland, died at his home in that city on Jan. 7, at the age of 67 years. For many years, Mr. Boughton had been an active leader in the development of sand preparing and conveying equipment. He was one of the first to realize the possibilities of sand preparing machinery, and the core sand mixer which he designed in 1900, was the first machine of this kind ever built. During his long association with the foundry industry he devoted his entire attention to the mining of molding sand and to the development of automatic equipment for handling this sand to the best advantage. Mr. Boughton was born in Akron, O., Nov. 22, 1848, and after graduating from the public schools of that city, gained his first experience as a salesman. Later he began the manufacture of bed springs at Wooster, O., and subsequently took up the making of agricultural implements. In 1880 he opened a molding sand pit at Portage, O., thus beginning an active association with the foundry industry that embraced a period of 36 years. This business was carried on under the name of the Standard Sand Co. He was one of the earliest to see the need for mechanical mixing of core sands and the study which he gave to this problem resulted in the development of the first core sand mixer in 1900. At the same time, the company was re-incorporated as the Standard Sand & Machine Co., Mr. Boughton becoming president of the company, a position which he held continuously until the time of his death.

The company's business has been broadened to include not only the furnishing of molding sand and sand preparing machinery, but also the manufacture of elevating and conveying machinery for the continuous handling of sand and molds. The molding sand branch of the business has been maintained, the Portage pits being abandoned some years ago, for several new deposits opened in the upper Cuyahoga valley. Mr. Boughton was one of the first manufacturers to mill molding sand, his original mill being built at Everett, O. The sand pits now being worked by the company include those at Summerdale, O., New Cumberland, O., and Wooster, O.

Death followed only a few days' illness from pneumonia. Mr. Boughton had been in poor health for several years. He is survived by a widow, two sons and one daughter. The sons, John A. and Harry E., are vice president and treasurer, respectively, of the Standard Sand & Machine Co.



HORACE G. BOUGHTON

New Electric Steel Co.

The Apollo Electric Steel Co., Apollo, Pa., has been organized with $500,000 capital to engage in the manufacture of electric steel. Two electric furnaces of the basic type will be installed and will be furnished by the Snyder Electric Furnace Co., Chicago.

Death of George H. Cushing

George H. Cushing, superintendent of the north and south plants of the H. B. Smith Co., Westfield, Mass., died Thursday, Dec. 30. Mr. Cushing was born in Worcester, Mass., Oct. 13, 1860, but at an early age his parents moved to Westfield, where he received his primary education in the public schools of that town. He was a graduate of Worcester Polytechnic Institute and after leaving school he became associated with the H. B. Smith Co., and subsequently was appointed assistant superintendent. He left the employ of the H. B. Smith Co. to accept the position of superintendent of the Goulds Mfg. Co., Seneca Falls, N. Y., where he remained for 13 years. Next he was placed in charge of a foundry in Montreal, Can., but in 1906 he returned to Westfield in the capacity of superintendent of the H. B. Smith Co.'s plants. He is survived by his widow, a son and a daughter.

Book Review

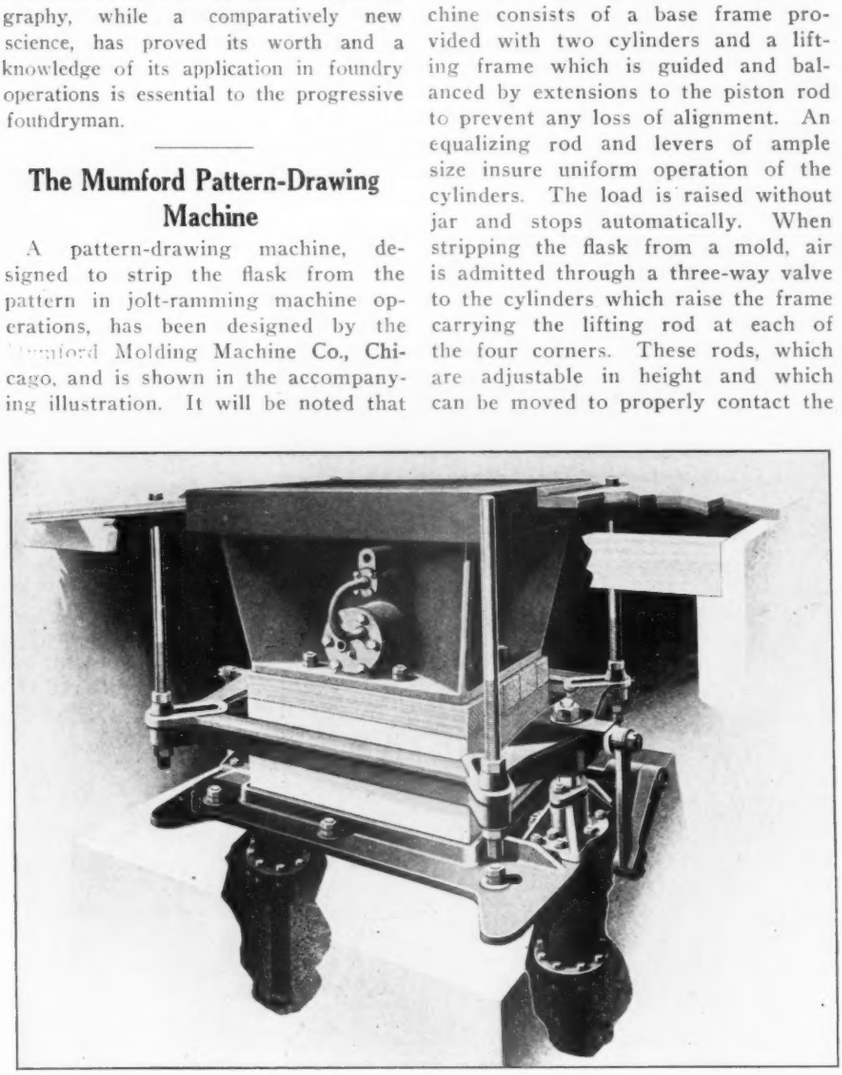
The Metallography and Heat-Treatment of Iron and Steel, by Albert Sauveur; second edition, 504 pages, 438 illustrations, furnished by *The Foundry,* $6 postpaid.

The work is a fully revised edition of Prof. Sauveur's *Metallography of Iron and Steel,* published in 1912. In view of the fact that a large portion of the book is devoted to the study of heat-treatment, the author adopted the new title, which seems to be more accurately descriptive of its contents. Fifty pages of new matter and nearly 100 new illustrations have been added in this revision and practically every chapter has been revised to cover recent developments in the metallography of iron and steel and the applications of theoretical considerations to industrial practice in the domain of heat-treatment. In the present edition the author has continued to pursue the course previously adopted by him to utilize the best illustrations available rather than use his own to the exclusion

of others. Considerable space is devoted to cast iron, cast steel and malleable cast iron and foundrymen desirous of keeping pace with late progress should add this work to their libraries. Metallography, while a comparatively new science, has proved its worth and a knowledge of its application in foundry operations is essential to the progressive foundryman.

The Mumford Pattern-Drawing Machine

A pattern-drawing machine, designed to strip the flask from the pattern in jolt-ramming machine operations, has been designed by the Mumford Molding Machine Co., Chicago, and is shown in the accompanying illustration. It will be noted that this pattern-drawing machine is independent of the jolt rammer, but is installed in the pit and on the same foundation with the jolt-ramming machine. Therefore, it can be applied to jolt-ramming machines now in use. By the use of this pattern-drawing machine the capacity of a jolt rammer is greatly increased. In one foundry two men and one core setter, by the use of a jolt rammer and this pattern-drawing machine, made 155 molds per day of a cream separator body weighing 59 pounds and which required the setting of four cores in each mold. In molding a cream separator base casting, weighing 56 pounds and which required one core for each mold, four men and one core setter made 130 molds per day, as compared with 45 molds made on a different type machine and without the use of this pattern drawing-device.



MUMFORD JOLT RAMMER EQUIPPED WITH A PATTERN-DRAWING MACHINE

As shown in the accompanying illustration, this pattern-drawing machine consists of a base frame provided with two cylinders and a lifting frame which is guided and balanced by extensions to the piston rod to prevent any loss of alignment. An equalizing rod and levers of ample size insure uniform operation of the cylinders. The load is raised without jar and stops automatically. When stripping the flask from a mold, air is admitted through a three-way valve to the cylinders which raise the frame carrying the lifting rod at each of the four corners. These rods, which are adjustable in height and which can be moved to properly contact the stripping plate or flask, engage the lower side of the stripping plate or flask joint, lifting the flask away from the pattern, the latter being attached to the table of the jolt-ramming machine. After the flask is carried away, air is admitted to the upper end of the cylinders and the frame lowers the stripping plate back to its correct position on the jolt-rammer.

Modeling Clay as an Adjunct to the Foundry

(*Continued from page* 70.)

shown at *F-F*, Fig. 4. When the clay had served its purpose, it was easily detached by pulling and came away clean. It adhered strongly enough to withstand rapping the pattern and molding and also made a clean mold. In Fig. 5 is shown another pattern for iron castings which was later adapted to a new purpose, a boss and a partition being built on. The boss was simply another pattern that lent itself to the purpose in hand, and it was attached to the large pattern with a thin layer of plasticine between the two. The change was sufficiently permanent for a number of castings to be made. At *G*, Fig. 6, the plasticine is shown as a filler for cracks, and at *H* it is used to smooth a rough corner.

Patterns can, of course be modeled outright from plasticine; holes can be filled and missing lugs or bosses can be formed and added to the pattern. Casting in aluminum or plaster of Paris can be made from the plasticine model and be used alone or as additions to other patterns. It is also frequently useful in making plaster of Paris core boxes, as the core can be modeled to shape in plasticine and plaster of Paris cast around this clay form, from which it will separate without the necessity of oiling. Many other uses for this material will readily commend themselves to both foundryman and patternmaker.

Personal

Samuel Stoneham has resigned as superintendent of the Michigan Steel Casting Co., Detroit.

Maynard D. Church has been appointed chief engineer of the Terry Steam Turbine Co., Hartford, Conn.

James F. Webb has been appointed assistant foreman of the foundry operated by the Bettendorf Co., Davenport, Ia.

Glen B. Hastings, 1511 Lytton building, Chicago, has been appointed representative of Hamilton & Hansell, New York City, for the sale of the Rennerfelt electric furnace in the states of the middle west.

A. F. Sterling Blackwood has resigned as vice president and manager of the Michigan Steel Casting Co., Detroit. Under his management the plant has grown from a small crucible foundry to one of the largest small steel casting shops in the United States.

J. D. Alexander, formerly affiliated with R. G. Dun & Co., Cleveland, has been appointed sales representative of the Sand Mixing Machine Co. and the American Foundry Equipment Co., New York and Cleveland. Mr. Alexander will sell both sand mixing machines and sand blast equipment in western New York, western Pennsylvania, Ohio, Kentucky and sections of Michigan and Indiana.

E. C. Waldvogel has been appointed general manager of the Yale & Towne

Mfg. Co., New York City, with works at Stamford, Conn., and St. Catherines, Ont. Mr. Waldvogel has been affiliated with the Yale & Towne Mfg. Co. for 11 years and has successively filled the positions of traveling salesman, sales manager and assistant general manager. In addition to his regular duties, Mr. Waldvogel will have general supervision of domestic, Canadian and export sales.

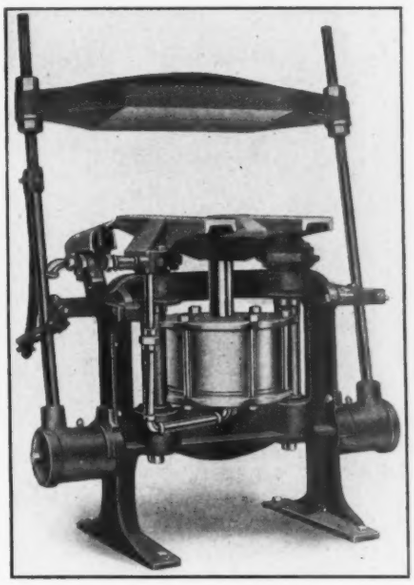
A. S. Baldwin has resigned as works manager of the R. D. Nuttall Co., Pittsburgh, to accept a position as manager of ordnance of the Poole Engineering & Machine Co., Baltimore, which now is filling contracts approximating $19,000,000 for foreign governments. Prior to his connection with the R. D. Nuttall Co., Mr. Baldwin was affiliated, in the capacity of general manager, with the Alberger Pump & Condenser Co., Newburg, N. Y., for a period of three years, was general superintendent of the Driggs-Seabury Ordnance Corp., Sharon, Pa., for 4½ years and for two years he was superintendent of the American-British Mfg. Co., Bridgeport, Conn.

P. G. Smith has retired from the staff of the E. J. Woodison Co., foundry supply manufacturer, Detroit, to assume a position with the sales department of the American Malleables Co., Lancaster, N. Y., and Owosso, Mich. In consequence of Mr. Smith's resignation, several changes have been made in the Woodison organization. W. J. Wark has been appointed to succeed Mr. Smith as manager of the Buffalo office. R. H. Mills has been appointed manager of the Cleveland office, succeeding A. F. Jordan, who now has charge of northern Ohio and Michigan territory, with headquarters at Detroit. M. H. Thompson has been appointed manager of the Portland branch, succeeding Mr. Mills. C. J. Menzemer has been appointed to a position with the plating and polishing department, with headquarters at Toronto.

Recognizing that higher speed, better work and greater human efficiency are possible in a stable structure as compared with a vibrating one, the Aberthaw Construction Co., Boston, is undertaking an exhaustive investigation in an effort to bring together conclusive evidence bearing on this subject. It is realized that data proving this fact are difficult to obtain and, therefore, the Aberthaw company will appreciate suggestions or reports of experiences that others may have had along this line. These may have to do with any aspect of the case that will assist in the collection of facts or the reaching of conclusions.

New Power Squeezer

The B. & B. Mfg. Co., Indianapolis, has designed and is manufacturing a new type of power-operated squeezer molding machine, which is furnished both stationary and portable. As shown in the accompanying illustration, the cylinder of the power unit is made of brass and power units may be selected of a size adapted to the work and the air pressure available. The power unit readily can be changed and a larger one substituted for a smaller one or *vice versa*, as the work may require. The cylinders are changed by disconnecting the air pipe and raising the mold table, when the cylinder will drop out of the



POWER SQUEEZER BUILT BY THE B. & B. MFG. CO., INDIANAPOLIS

machine. The power units are designed to cushion the mold table in returning to its position of rest. This feature insures accurate work from the patterns, which are not jarred down into the drag of the mold after it has been squeezed. The speed of the table and its return to its position of rest can be increased by enlarging the small opening in the side of the brass cylinder. In the event of the application of the air pressure without a flask on the table, the piston contacts with an air cushion and the pressure below the piston is automatically released. This is a safety feature of great value. The valve is simple in construction and quick-acting, a slight pressure of the hand operating the intake and when the pressure is removed, the exhaust is immediately opened. The mold table is rigidly guided by two wide-spaced guide posts, one on each side of the power unit. These guide posts slide in sleeves set in the frame. The sleeves are renewable, thereby insuring a long period of service for the machine. All operating parts are well protected from sand. The machine may be equipped with any standard table vibrator or a knee valve and is built in the following sizes: Stationary, 24 and 30-inch with 8-inch power unit, and 24 and 30-inch with 10-inch power unit; portable, 30 and 36-inch with 10-inch power unit, 30 and 36-inch with 12-inch power unit and 26-inch with 14-inch power unit.

Profit-Sharing With Sales Force

On Tuesday evening, Dec. 28, the Federal Foundry Supply Co., Cleveland, entertained its sales force at a banquet at the Cleveland Athletic Club. Walter J. Adams, president, and Ralph Ditty, secretary and treasurer of the company, delivered addresses which were responded to by each one of the salesmen. In appreciation of the services of the good work of the sales force during the past year, each representative was presented with five shares of stock and it is stated that it is the intention to continue this practice while business continues prosperous and until each representative has a reasonable interest in the company. Announcement also was made that R. A. Smith has been appointed New England representative of the Federal Foundry Supply Co., with headquarters at Boston, and I. D. Adams has been appointed New York state representative with Syracuse as headquarters.

Melting Manganese Copper

By DeCourcy Browne

In the January, 1916, issue of *The Foundry*, page 25, under the caption entitled "Melting Manganese Copper," it was stated that an exceedingly high temperature is required to effect a proper mixture. This mixture refers to pure carbon-free manganese metal and copper. We wish to advise you, however, that this is not entirely the case, inasmuch as we make many tons of this mixture and we find that on the contrary, the pure carbon-free manganese dissolves in copper at an exceedingly moderate temperature and no difficulty whatever is experienced in making an alloy consisting of 30 per cent manganese copper, technically free from iron and carbon.

Both the zinc smelting and zinc mining industries of the United States enjoyed a year of unparalleled prosperity in 1915. It is estimated that the recoverable zinc content of zinc ores mined in 1915 was over 560,000 tons, compared with 407,000 tons in 1914. While the total spelter produced in 1915 increased 40 per cent over the preceding year, the increase in the value of the output was much greater, being nearly 300 per cent.

WHAT THE FOUNDRIES ARE DOING

Activities of the Iron, Steel and Brass Shops

The Aluminum Holloware Co., Marion, Ind., has changed its name to the Marion Brass Foundry Co.

The Central Foundry Co., Marshalltown, Ia., has increased its capital stock from $12,000 to $25,000.

The Canada Brass Foundry Co., Ottawa, Ont., Can., has taken over the Excelsior hotel and will remodel it for manufacturing purposes.

The Lusk Foundry Co., Jackson, Mich., has changed its name to the Pioneer Foundry Co., Ltd.

The Novo Engine Co., Lansing, Mich., contemplates the erection of an addition to its foundry, 125 x 325 feet.

The Foundry, Motor Car & Mfg. Co., St. Albans, Vt., has leased the old plant of the Albans Foundry & Implement Co.

The King Foundry Co., St. Joseph, Mo., has increased its capital stock from $40,000 to $65,000 and will add to its equipment.

The Fahrenstock Mfg. Co., Union Bank building, Pittsburgh, Pa., contemplates the establishment of a steel foundry in Cincinnati.

The Central Foundry Co., Marshall, Mich., has been organized and has leased a plant, 66 x 150 feet.

M. P. Roebke has reopened the old Oestreich foundry and machine shop at Plymouth, Wis., and will do a general machinery and repair business.

The Snow Foundry Co., Chicago, has been incorporated with a capital stock of $16,000 by P. V. Snow, Stewart Snow and James S. Shaefer.

The Beloit Foundry Co., Beloit, Wis., has been incorporated with a capital stock of $10,000 by J. A. Janvrin, Paul Halverson, John Cosline and Henry Gau.

The Seaboard Foundry & Machine Co., Montclair, N. J., has been incorporated with $75,000 capital by H. J. Redfield, Jessie Rowland and William E. White.

The Western Machine & Foundry Co., Plattsmouth, Neb., is equipping a foundry and machine shop to engage in a general machinery business and is in the market for equipment.

The plant of the Danville Foundry & Machine Co., Danville, Ill., has been purchased by Robert Holmes & Bros. As soon as the plant is remodeled and enlarged their present shops will be removed.

The Kellogg Repair Sleeve Co., Jersey City, N. J., has been incorporated to engage in the manufacture of cast iron pipe sleeves with $10,000 capital. The incorporators are R. M. Kellogg, C. E. Corbin and C. K. Corbin.

The Parker Mfg. Co., manufacturer of heating and ventilating equipment, which has been operating at Florence, Ala., has removed its office to Chattanooga, Tenn., and contemplates the establishment of a foundry.

The G. H. Tod Co., Toronto, Ont., Can., has been incorporated to engage in business as an engineer, contractor and metal founder with $40,000 capital stock. Bruce E. Ingham, George H. Tod and Ethel M. Brown are the incorporators.

The Consolidated Steel Co., Toronto, Ont., Can., has been incorporated with $100,000 capital to engage in the iron foundry business and to build tools and machinery. The incorporators are William H. Beatty, Francis A. Hammond and Charles B. McClurg.

The Montreal Steel & Foundry Co., Ltd., Montreal, Can., has been incorporated with $150,000 capital to engage in the manufacture of iron and steel castings and machinery. Joseph C. Lamothe, Emilien Gadbois and Joseph M. Nantel are the incorporators.

New Construction

The Sparta Foundry Co., Sparta, Mich., is erecting an addition to its plant.

The McNaughton Grate Bar Co., Maryville, Tenn., contemplates enlarging its foundry.

C. H. Schutte, Watertown, S. D., will erect a foundry in Butte, Mont.

The Geneva Foundry & Machine Co., Geneva, Ill., will build a foundry, 55 x 100 feet.

The Illinois Malleable Iron Co., Chicago, will erect an addition to its gray iron foundry.

The Farrel-Cheek Foundry Co., Sandusky, O., contemplates doubling the capacity of the plant.

The Beaver Motor Car Co., Gresham, Ore., will build a foundry addition to its plant, 32 x 70 feet.

The Liberty Foundry Co., St. Louis, Mo., will build an addition to its foundry at a cost of $2,500.

The Bates Machine Co., Joliet, Ill., will build additions to its foundry and machine shops at a cost of $100,000.

The South Bend Foundry Co., South Bend, Ind., is erecting a 40 x 100-foot addition to its foundry.

The Canada Metal Co., Toronto, Ont., Can., will erect an addition to its plant costing approximately $25,000.

The Clark County Iron Works, Portland, Ore., will build a foundry at Tenth and Flanders street.

The Enterprise Brass Works, Muskegon Heights, Mich., is building a two-story plant, 80 x 150 feet, at a cost of $15,000.

Plans have been prepared for a 50 x 60-foot fireproof foundry addition to the plant of the Warner Fence Co., Ottawa, Kas.

Contract has been let by the Schneider-Bowman Co., Frankford, Philadelphia, Pa., for a two-story foundry, 50 x 100 feet.

The Quick Meal Stove Co., Twelfth and Couteau avenue, St. Louis, Mo., will build a brass foundry, 56 x 108 feet.

A contract has been awarded by the Gleason Works, Rochester, N. Y., for a 50 x 82-foot foundry; a one-story, 50 x 98-foot machine shop and a one-story, 32 x 48-foot case-hardening building.

The Allyne-Ryan Foundry Co., Aetna road and East Ninety-first street, Cleveland, will erect a $15,000 addition to its plant.

J. R. Chesley and Frank Broscha, Danville, Ill., are considering the erection of a foundry at Muskegon, Mich., for the manufacture of steam injectors.

The American Radiator Co., Buffalo, is asking for bids on an addition to its foundry. John E. Young, 30 North Dearborn street, Chicago, is the architect.

Contract has been awarded for the erection of a 110 x 150-foot foundry addition to the plant of the Syracuse Malleable Iron Co., Syracuse, N. Y.

The Goodale Co., Kalamazoo, Mich., will build a one-story, 90 x 250-foot foundry of concrete, steel and brick construction and a three-story shop.

The Chicago Clearing & Transfer Co. will build a foundry, one and two stories, 100 x 100 feet, at Clearing, Ill. Davidson & Weiss, Chicago, architects, are taking bids.

The R. E. Parsons Co., iron founder, has purchased a site at North Washington avenue and Frederick street, Bridgeport, Conn., and will build a plant.

The St. Louis Brass Mfg. Co., St. Louis, is building a six-story, 40 x 65-foot addition to its plant, of reinforced concrete construction. The estimated cost is $40,000.

The Dominion Steel Foundry Co., Hamilton, Ont., Can., will make extensive additions to plant, including the erection of four new buildings.

The Williston Steel & Foundry Co., Halifax, N. S., Can., will build a steel plant at Dartmouth, N. S., to cost approximately $16,000.

The Globe Malleable Iron & Steel Co., Syracuse, N. Y., is erecting a one-story, 80 x 90-foot die sinking building; a one-story, 80 x 90-foot storage building; a one-story, 40 x 60-foot press building and a one-story, 40 x 60-foot sand blast building.

Plans have been prepared for a two-story and basement, 60 x 100-foot foundry to be erected for the Denkman & Herms Co., Sioux City, Ia. The cost of the structure is estimated at approximately $40,000. F. E. Colby is the architect and bids will be called for shortly.

NEW TRADE PUBLICATIONS

STEAM TURBINE GENERATORS.—A 40-page catalog, issued by the General Electric Co., Schenectady, N. Y., is devoted to the Curtis steam turbine generator adapted for electric power generation. The general principles of the operation of this generator are graphically shown. One section of the catalog is devoted to illustrations showing various types of turbines, as well as representative turbine installations. The catalog is printed in two colors and is handsomely illustrated.

OIL SWITCHES.—In a bulletin recently issued by the General Electric Co., Schenectady, N. Y., small capacity industrial oil switches are illustrated and described. Another bulletin is devoted to luminous arc lamps of the pendent type. The distinguishing feature of this lamp is in the arc, which is formed between the positive upper electrode of copper and the negative lower electrode, which consists of a sheet steel tube containing a specially prepared composition.